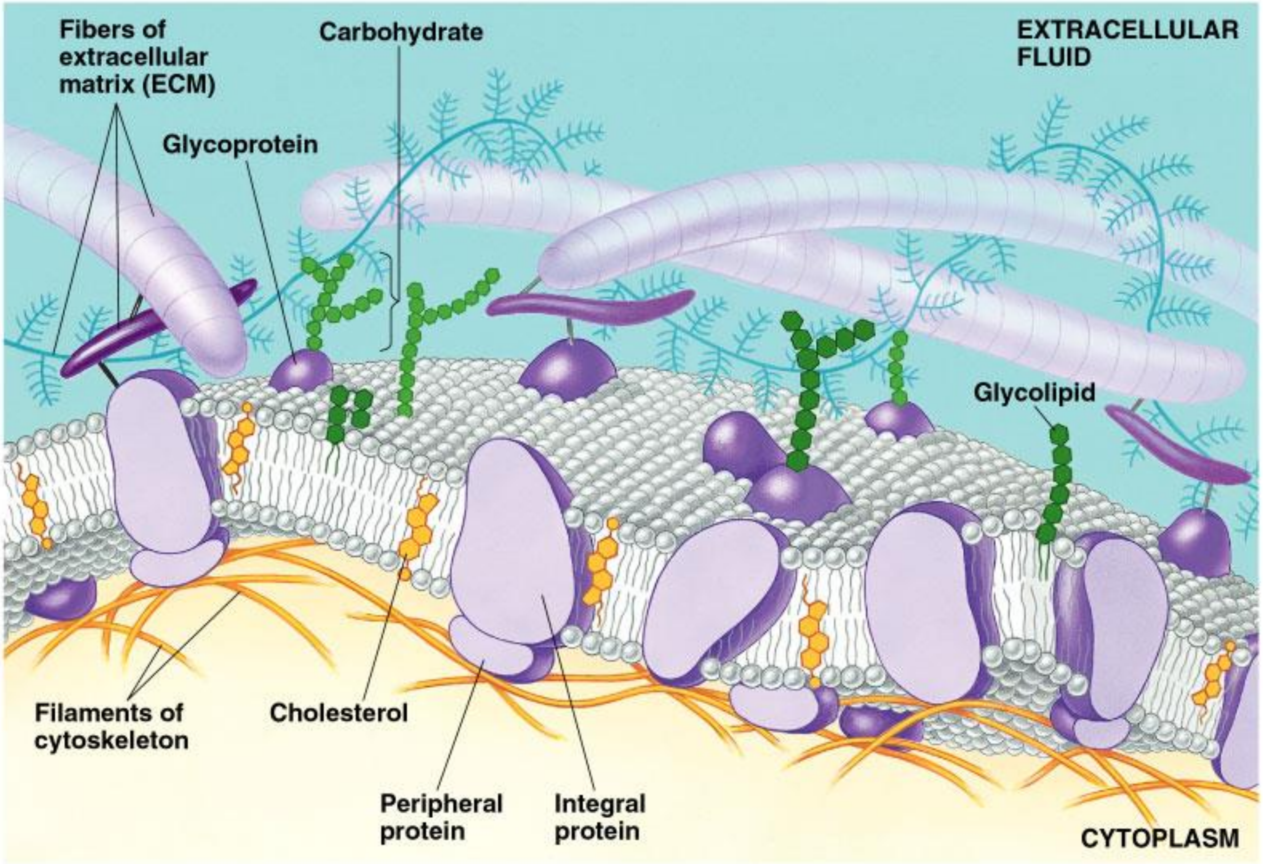
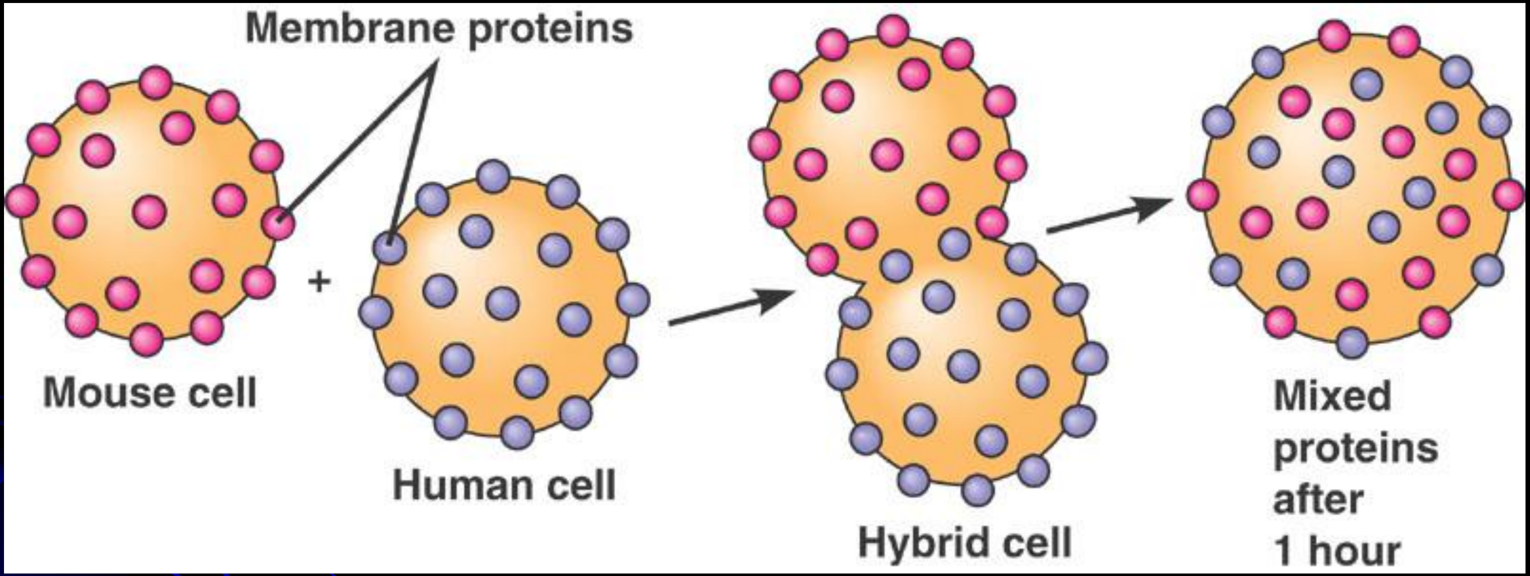
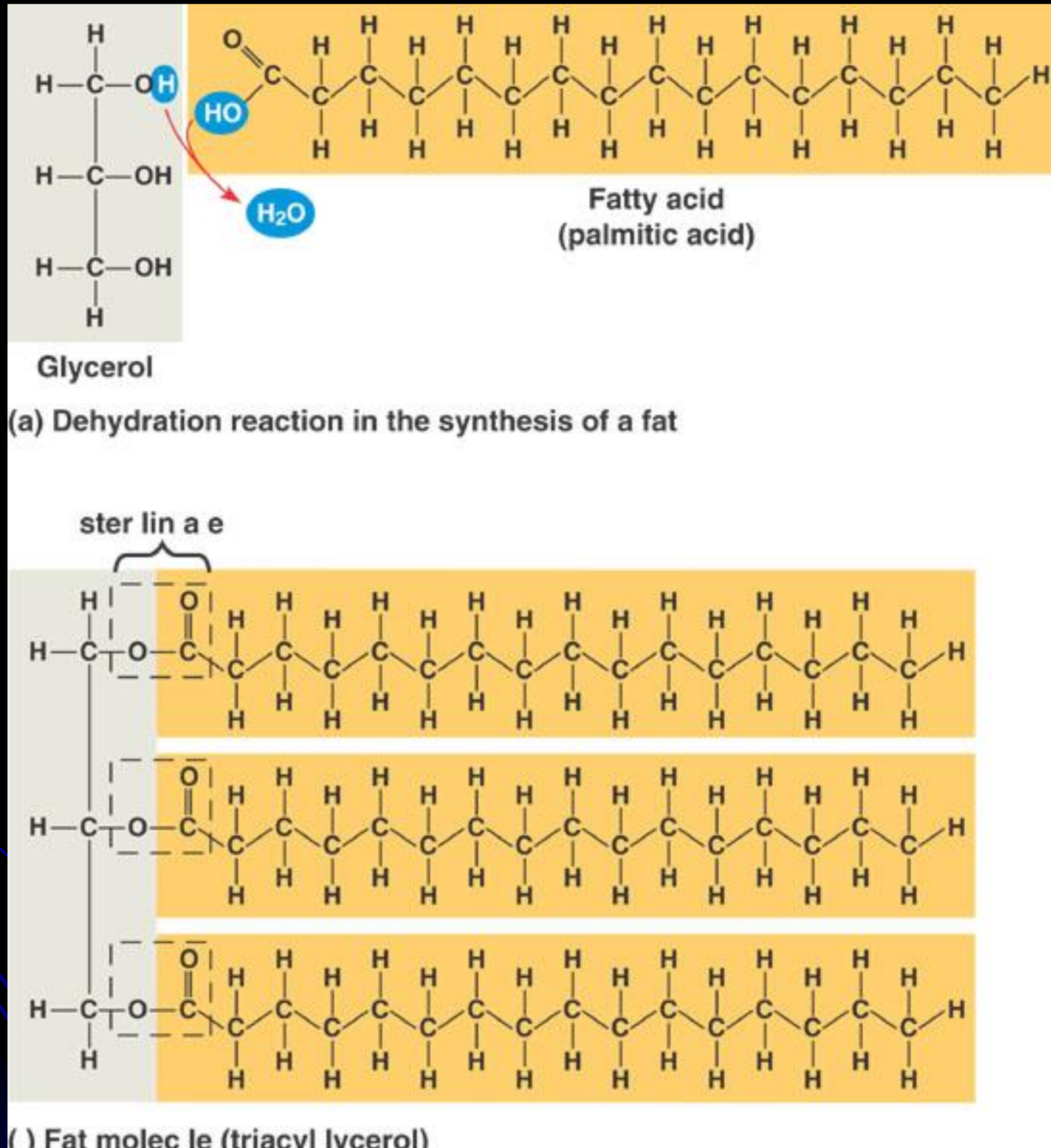
# Membranes-The fluid mosaic model



# Evidence for the drifting of membrane proteins



# The synthesis and structure of a fat, or triacylglyceride



# Figure 5.12 Examples of saturated and unsaturated fats and fatty acids

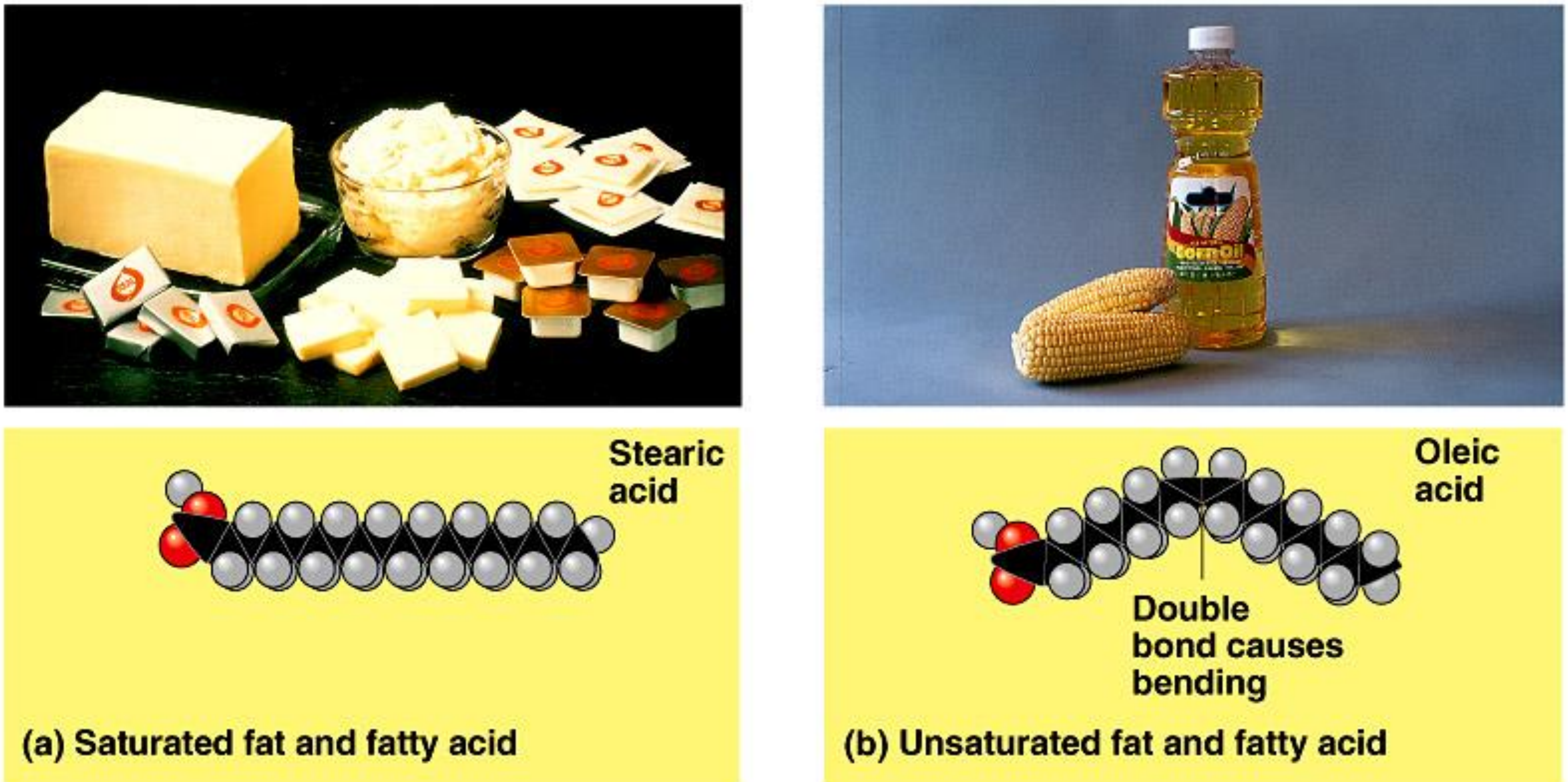
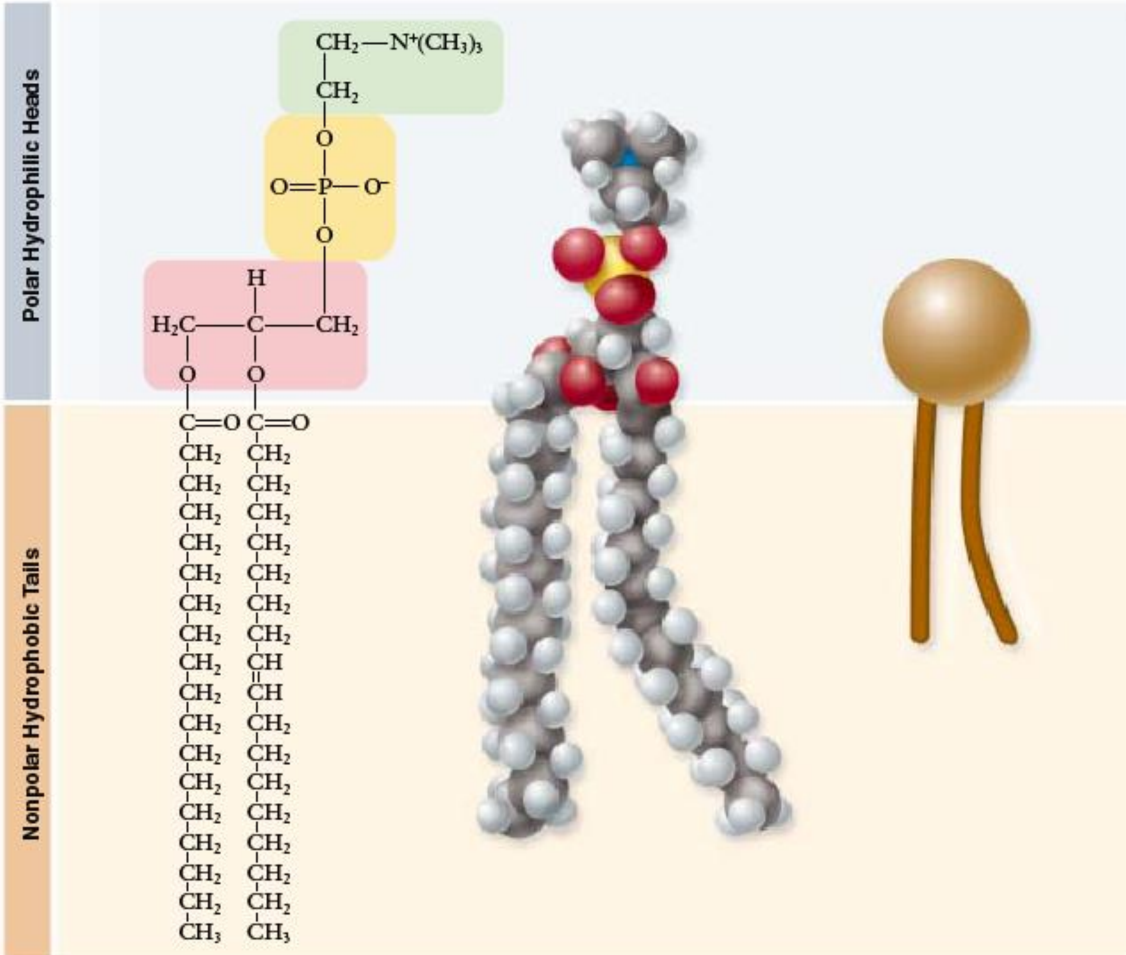


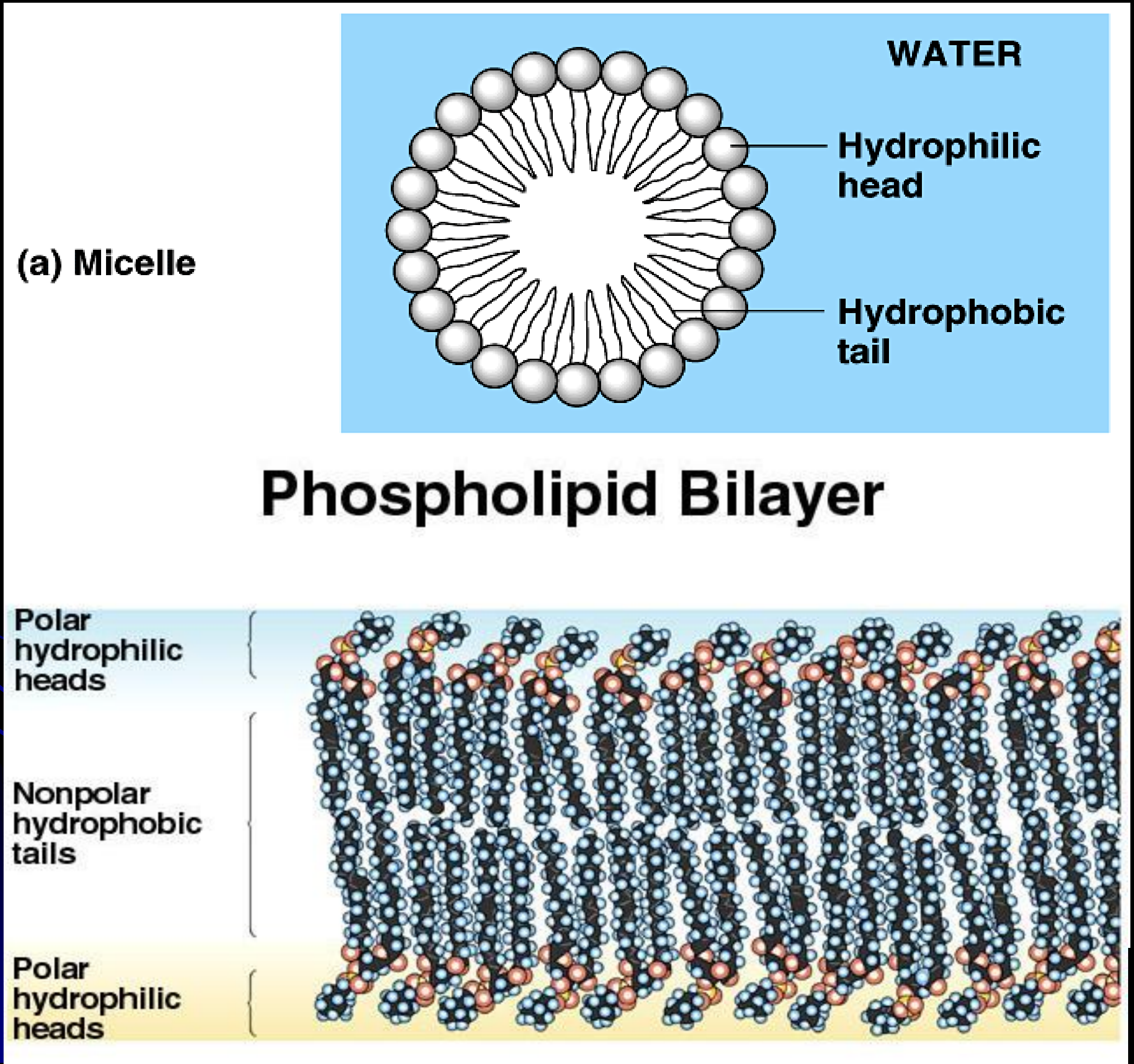
*figure 5.1*

**DIFFERENT VIEWS OF PHOSPHOLIPID STRUCTURE.** Phospholipids are composed of glycerol (*pink*) linked to two fatty acids and a phosphate group. The phosphate group (*yellow*) can have additional molecules attached, such as the positively charged choline (*green*) shown. Phosphatidylcholine is a common component of membranes, it is shown in ***(a)*** with its chemical formula, ***(b)*** as a space-filling model and, ***(c)*** as the icon that is used in most of the figures in this chapter. The phosphate portion of the molecule is hydrophilic, and the fatty acid tails are hydrophobic. This allows them to associate into bilayers, with the hydrophobic tails in the middle, in water.

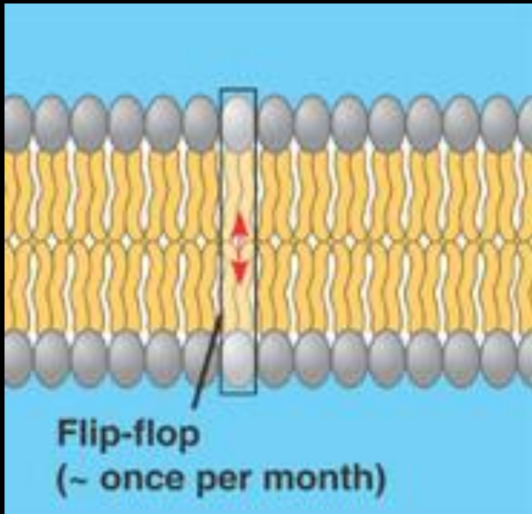


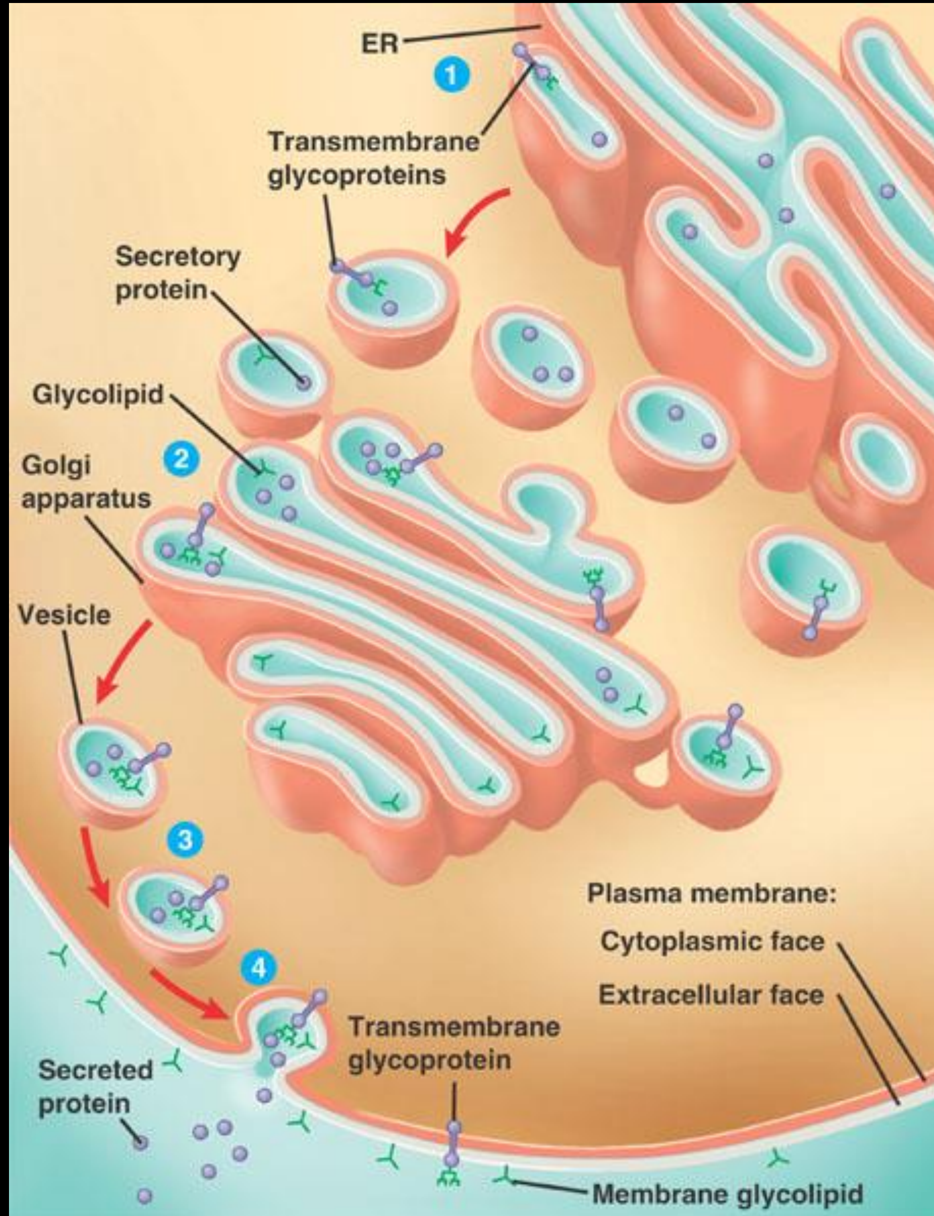

***a.*** Formula ***b.*** Space-filling model ***c.*** Icon

# Figure 5.14 Two structures formed by self-assembly of phospholipids in aqueous environments



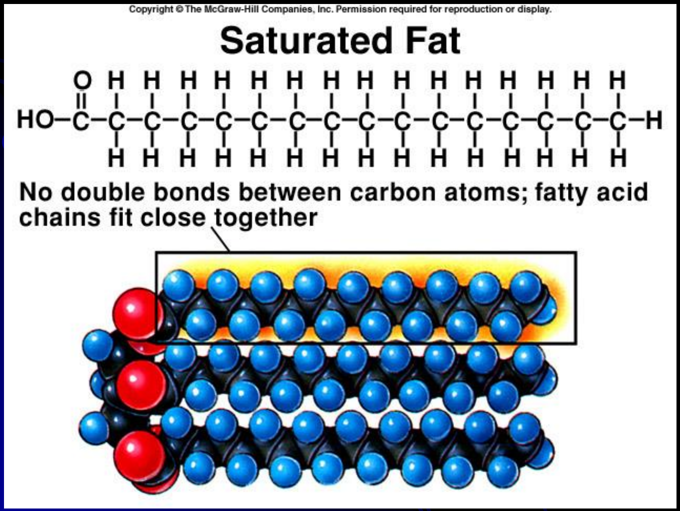
# Figure 7.10

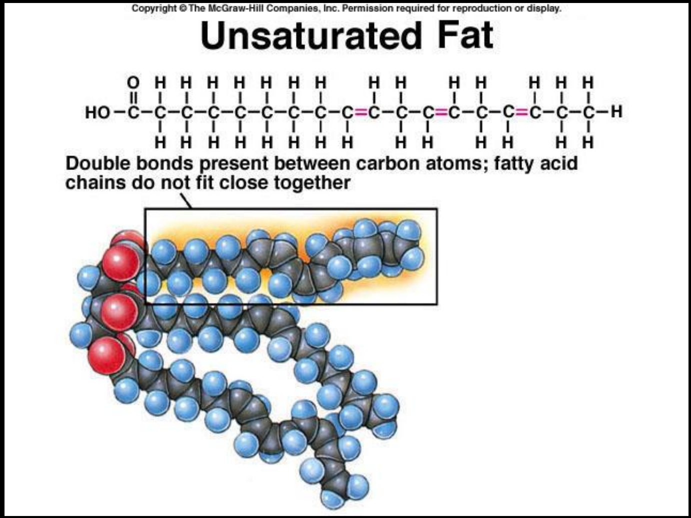

Flip-flop
(~ once per month)

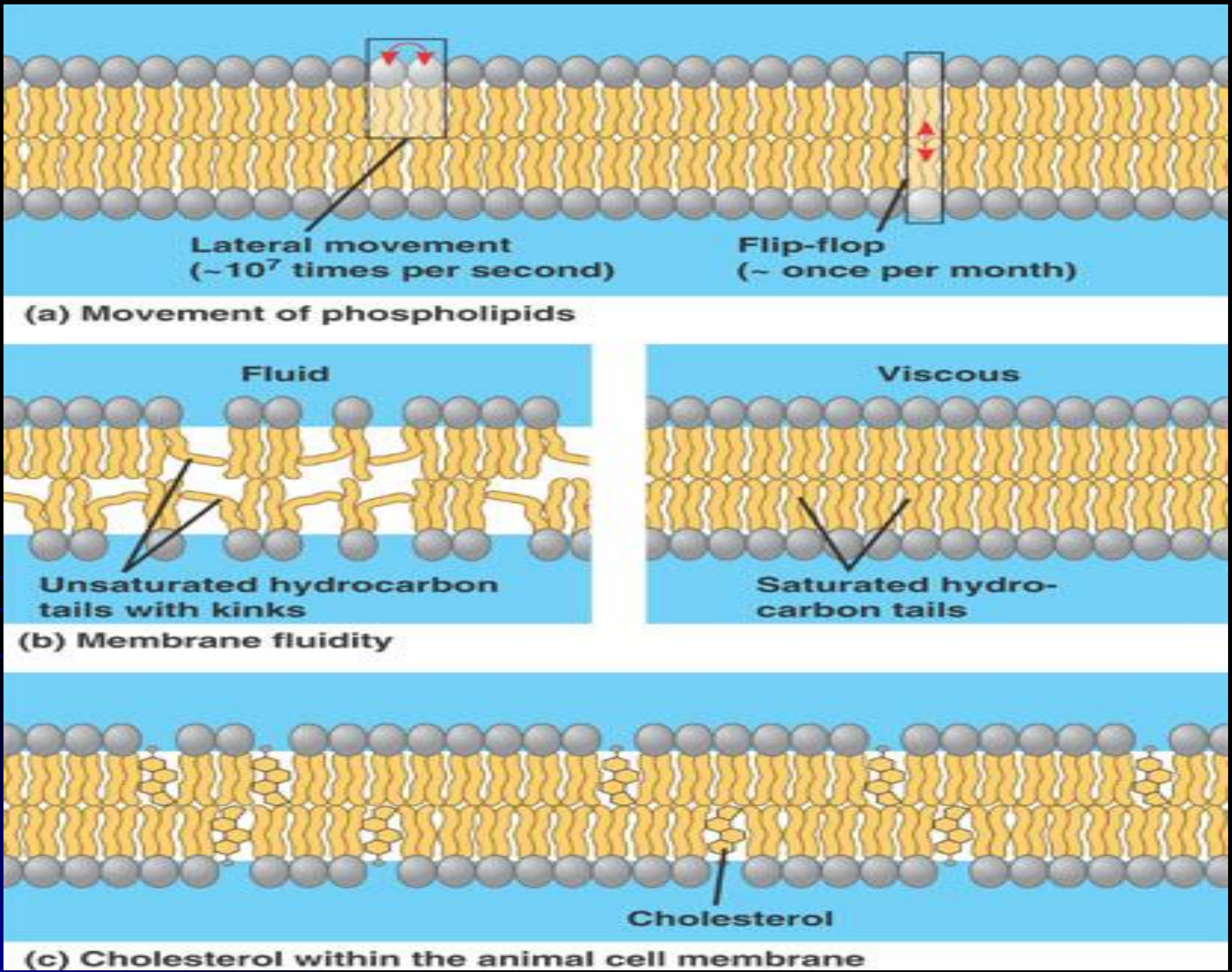

ER
1
Transmembrane
glycoproteins
Secretory
protein
Glycolipid
Golgi
apparatus
2
Vesicle
3
4
Transmembrane
glycoprotein
Secreted
protein
Plasma membrane:
Cytoplasmic face
Extracellular face
Membrane glycolipid

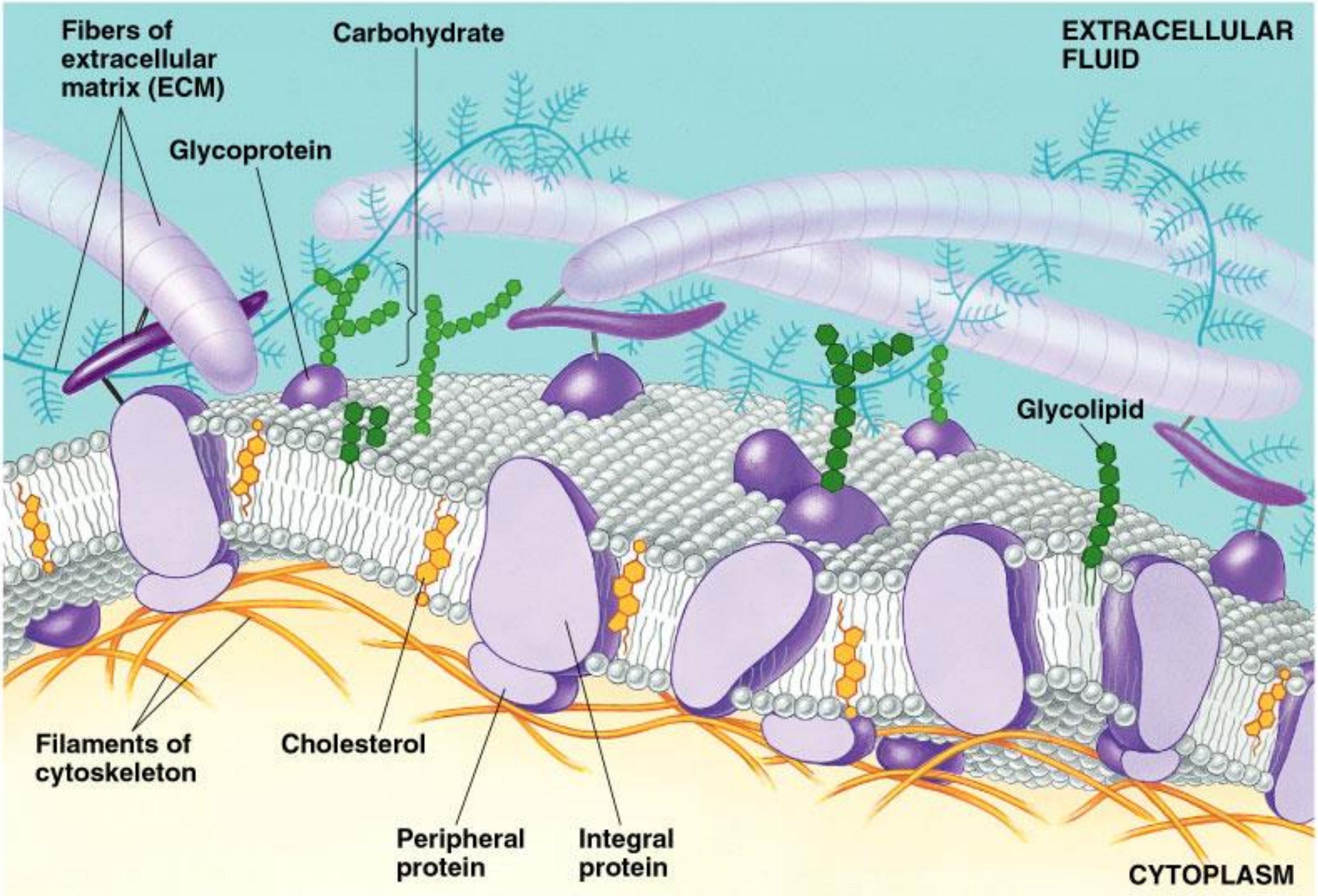
# Effects of unsaturation of phospholipids

- Fluidity of membrane
  - Important in cold blooded animals
    - Saturated fats have higher melting point
- Conversion to cholesterol
  - Harder to convert if more double bonds are present




Lateral movement
(~10^7 times per second)
Flip-flop
(~ once per month)
(a) Movement of phospholipids
Fluid
Viscous
Unsaturated hydrocarbon
tails with kinks
Saturated hydro-
carbon tails
(b) Membrane fluidity
Cholesterol
(c) Cholesterol within the animal cell membrane


Fibers of extracellular matrix (ECM)
Carbohydrate
EXTRACELLULAR FLUID
Glycoprotein
Glycolipid
Filaments of cytoskeleton
Cholesterol
Peripheral protein
Integral protein
CYTOPLASM

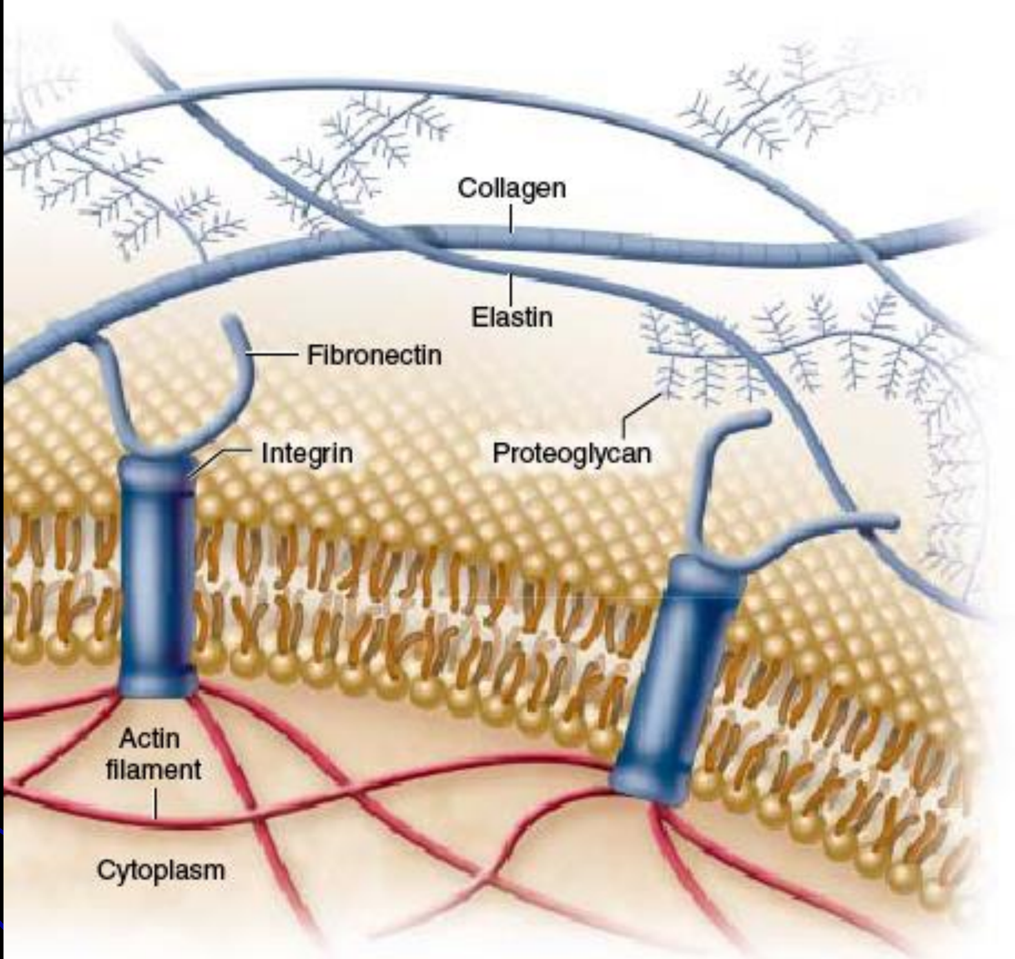
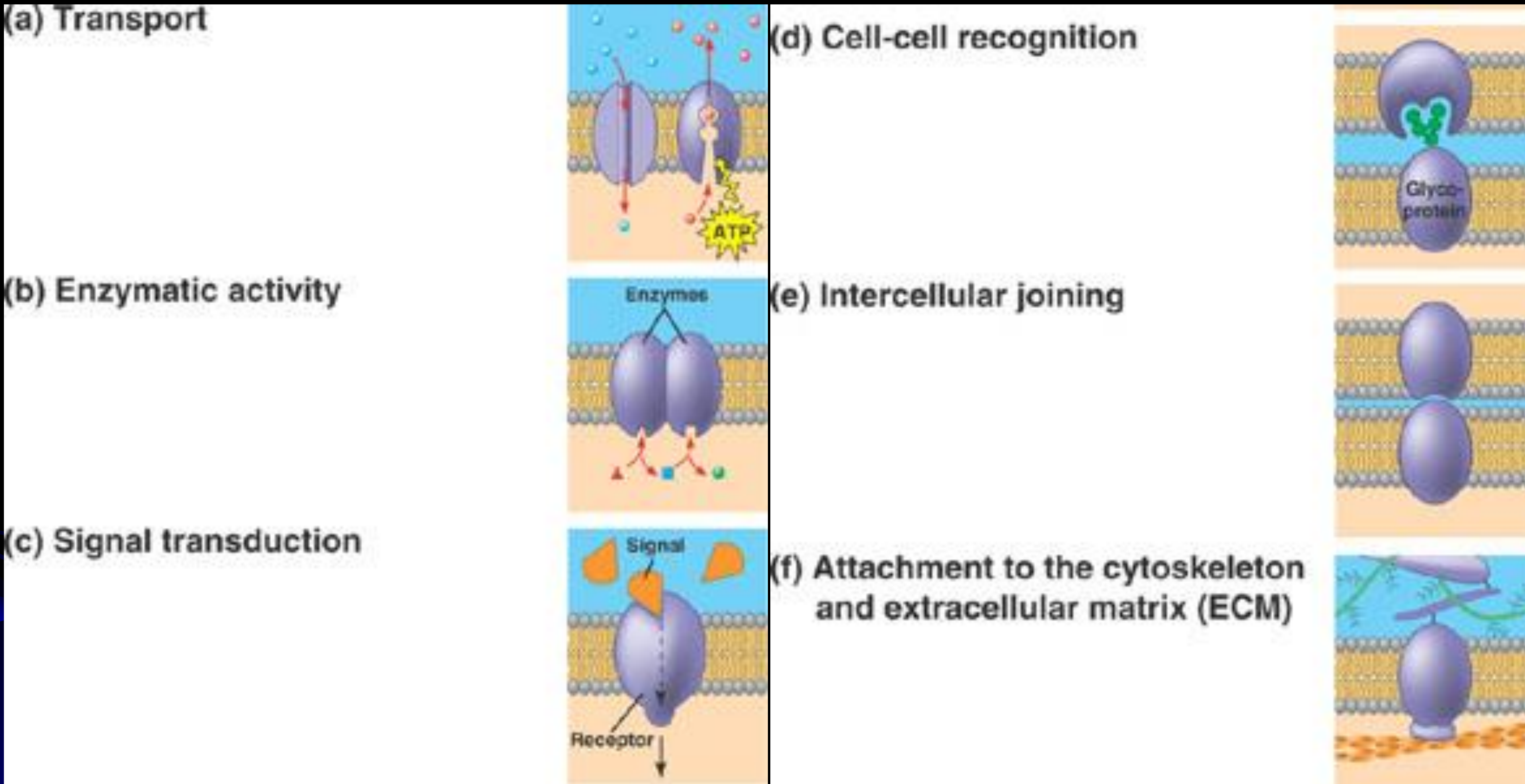


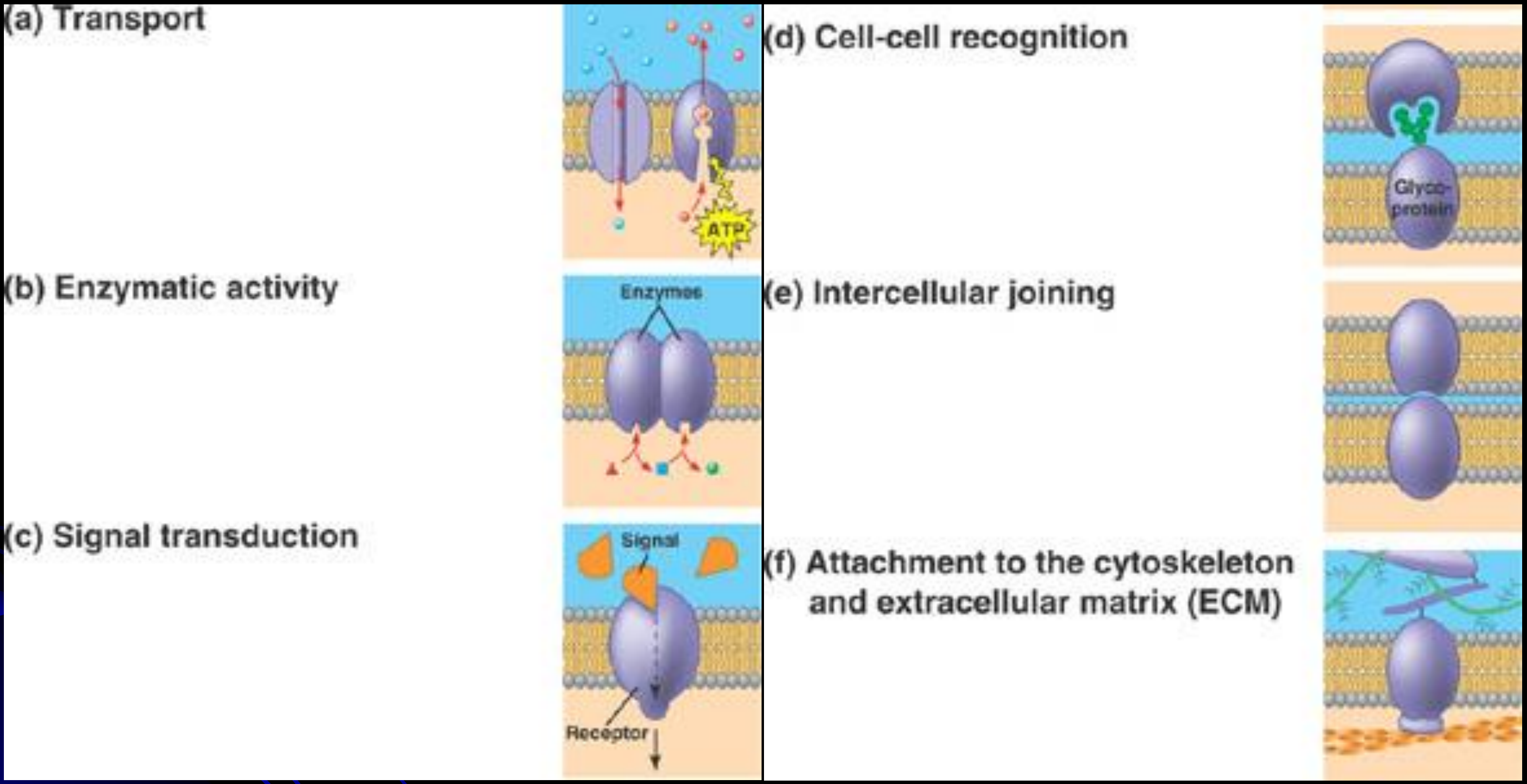

*figure 4.26*

THE EXTRACELLULAR MATRIX. Animal cells are surrounded by an extracellular matrix composed of various glycoproteins that give the cells support, strength, and resilience.

# Some functions of membrane proteins



# Transport


(a) Transport
ATP
(b) Enzymatic activity
Enzymes
(c) Signal transduction
Signal
Receptor
(d) Cell-cell recognition
Glyco-
protein
(e) Intercellular joining
(f) Attachment to the cytoskeleton
and extracellular matrix (ECM)

# Permeability of membranes

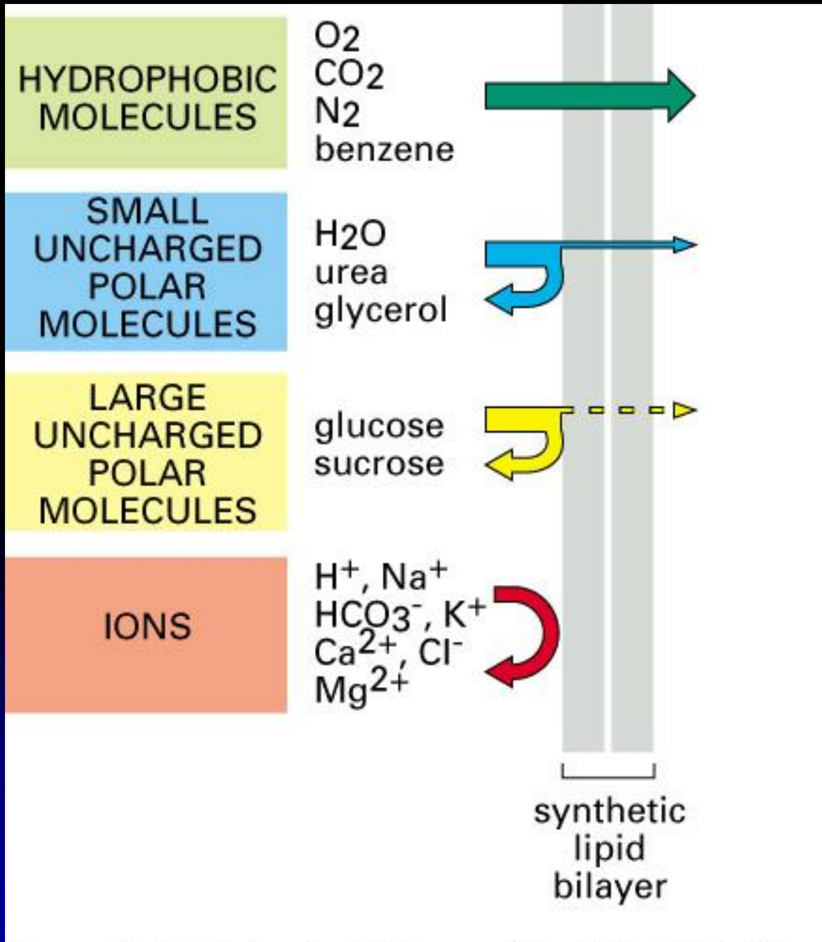


Figure 11–1. Molecular Biology of the Cell, 4th Edition.

- Can pass through the lipid bilayer-
  - Small polar molecules (water)
  - Non-polar molecules
    - Small molecules and those less strongly associated with water will pass across membrane
- Cannot pass through the lipid bilayer-
  - Large polar molecules
  - Charged molecules

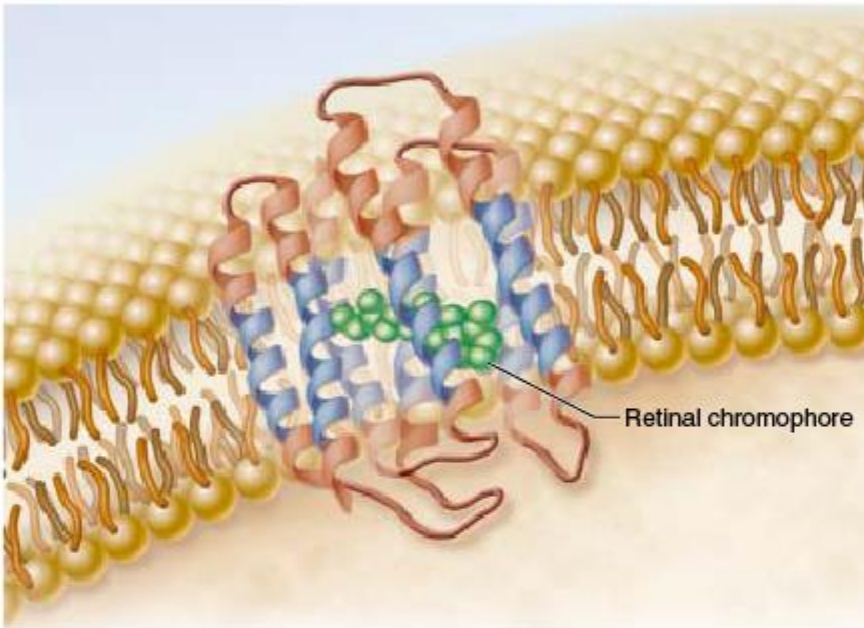
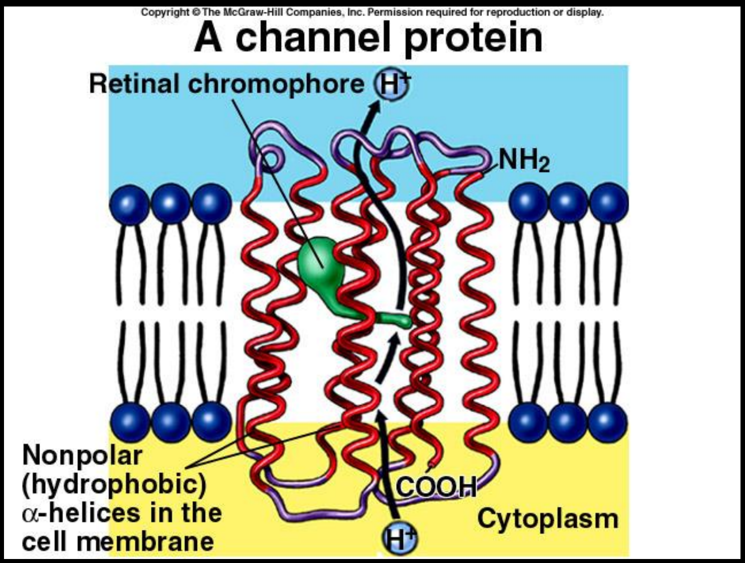



*figure* 5.7

**BACTERIORHODOPSIN.** This transmembrane protein mediates photosynthesis in the archaean *Halobacterium salinarium*. The protein traverses the membrane seven times with hydrophobic helical strands that are within the hydrophobic center of the lipid bilayer. The helical regions form a structure across the bilayer through which protons are pumped by the retinal chromophore (*green*) using energy from light.



# Porin

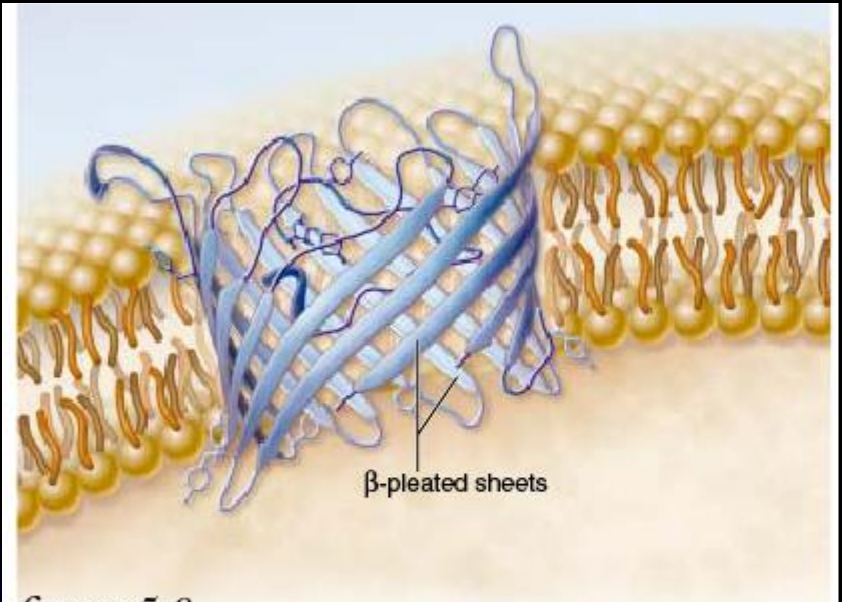
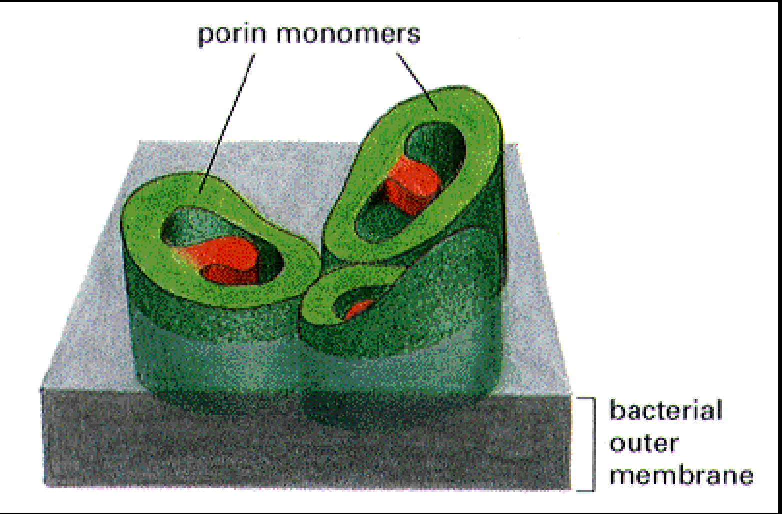


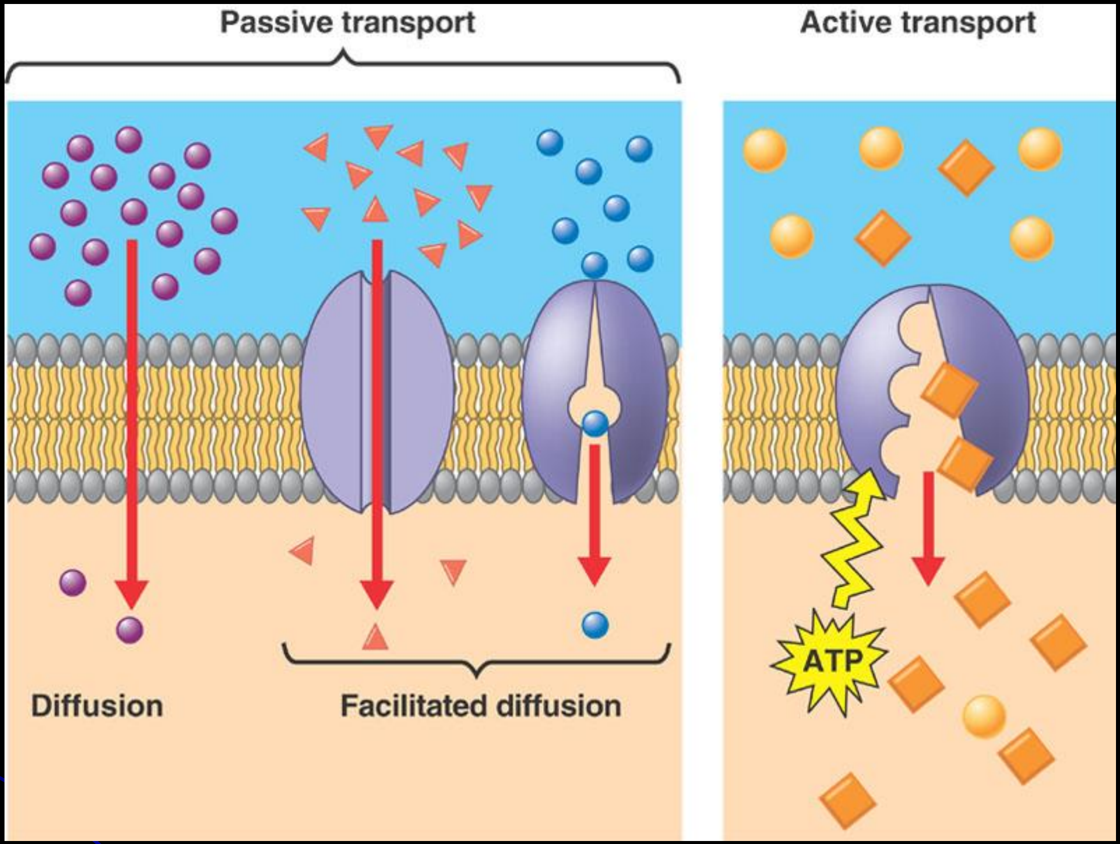

*figure 5.8*

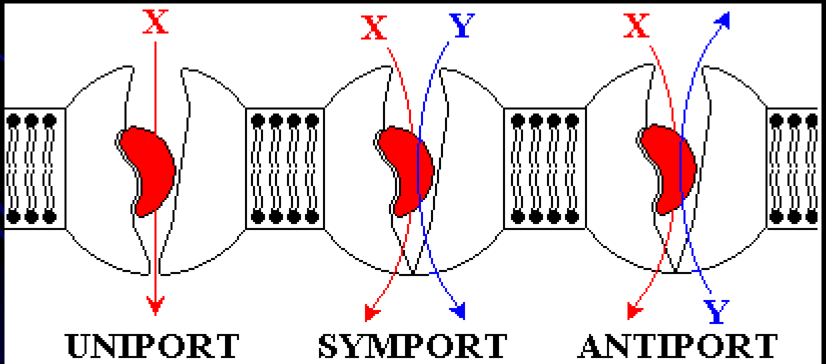
A PORE PROTEIN. The bacterial transmembrane protein porin creates large open tunnels called pores in the outer membrane of a bacterium. Sixteen strands of β-pleated sheets run antiparallel to one another, creating a so-called β-barrel in the bacterial outer cell membrane. The tunnel allows water and other materials to pass through the membrane.



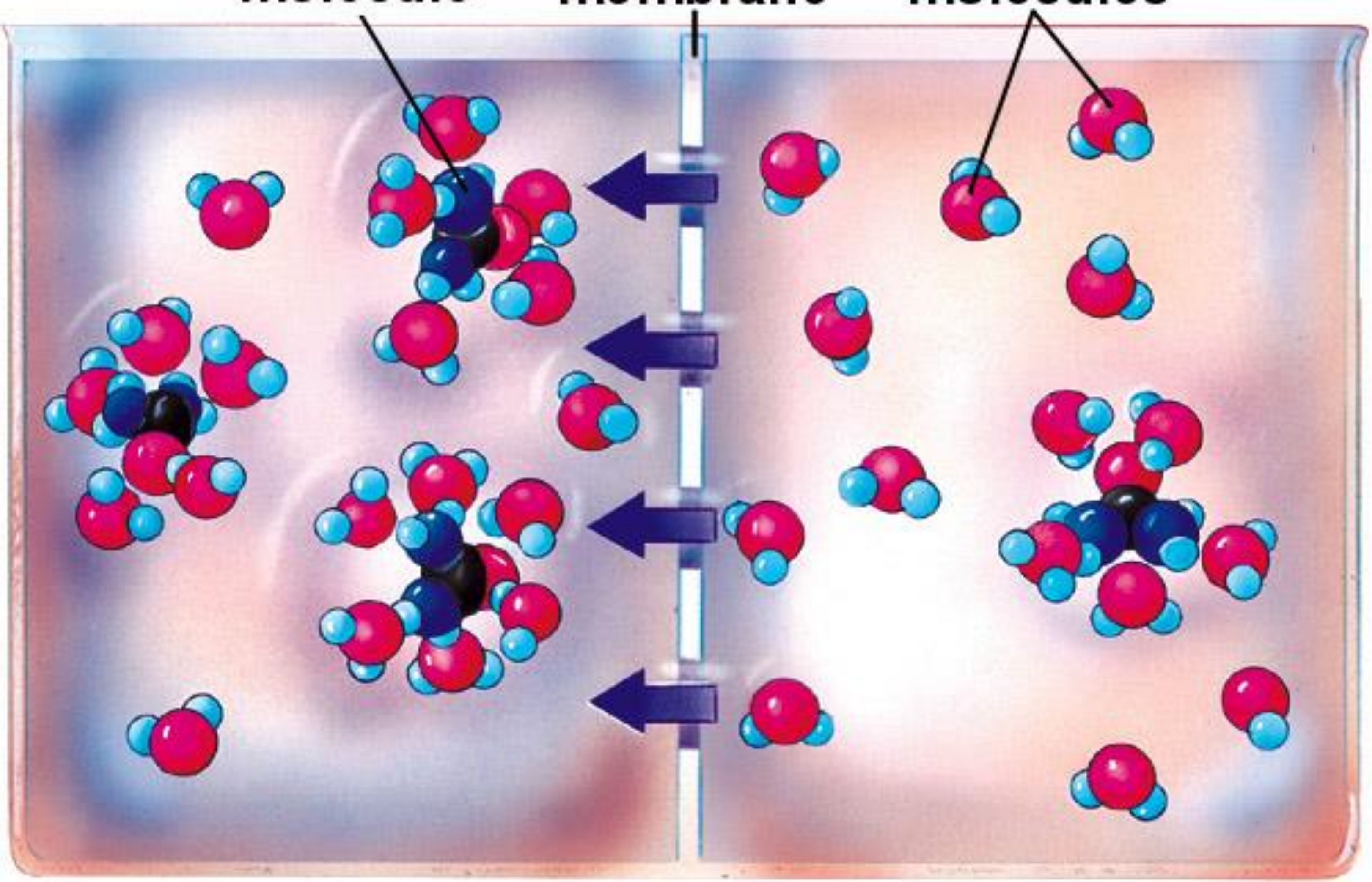

http://www.ncbi.nlm.nih.gov/Structure/mmdb/mmdbsrv.cgi?uid=66323

# Passive and active transport compared



# Osmotic Pressure



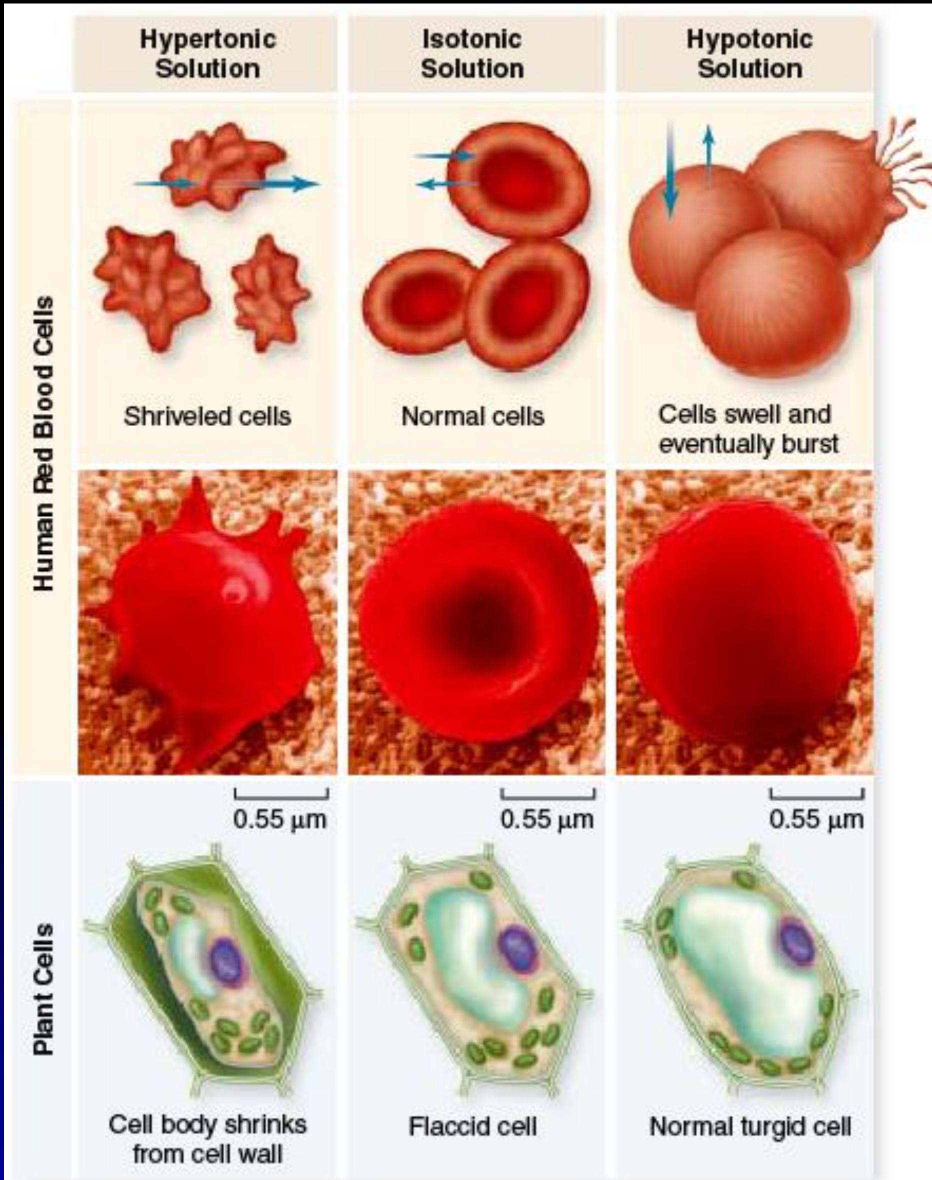
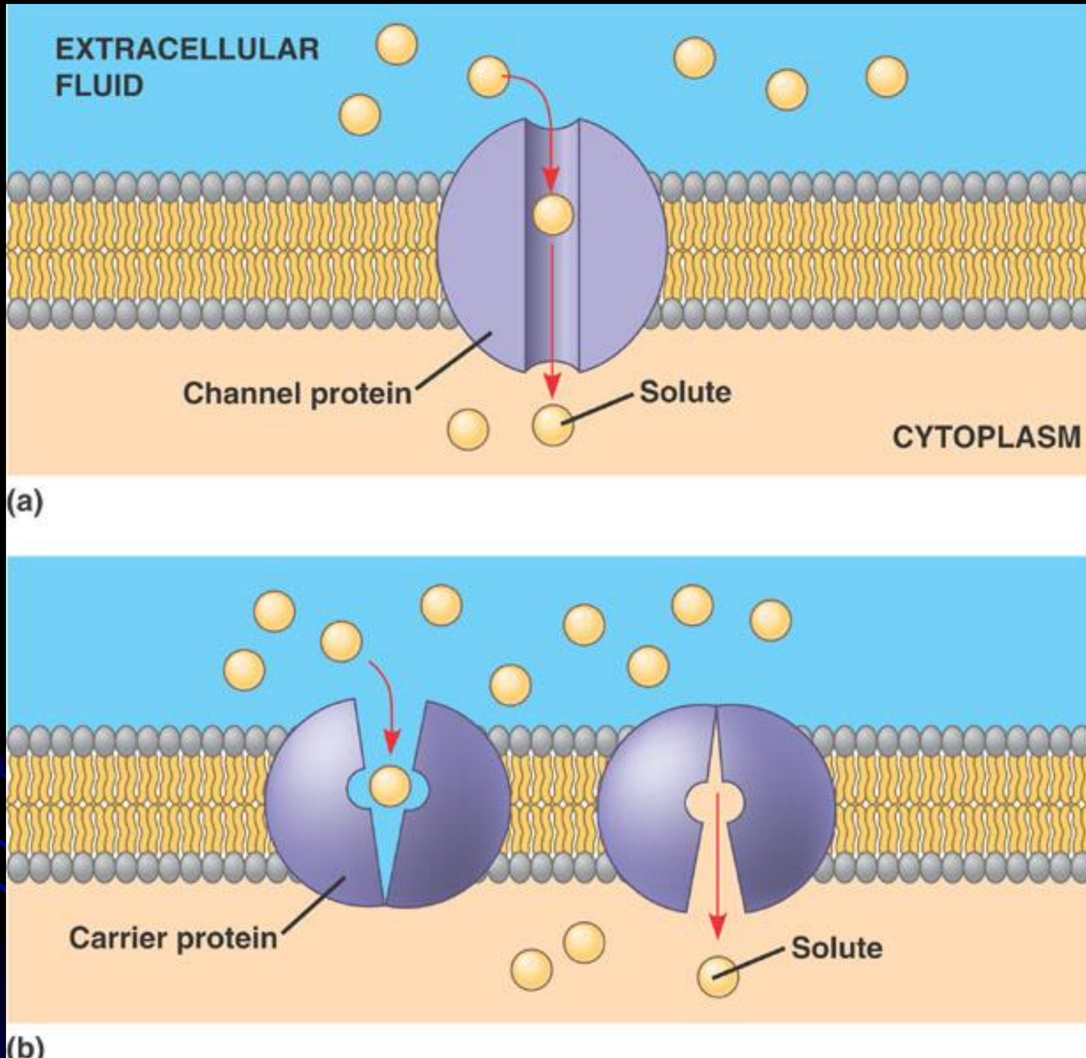



*figure 5.13*

**HOW SOLUTES CREATE OSMOTIC PRESSURE.** In a hypertonic solution, water moves out of the cell causing the cell to shrivel. In an isotonic solution, water diffuses into and out of the cell at the same rate, with no change in cell size. In a hypotonic solution, water moves into the cell. Direction and amount of water movement is shown with blue arrows (top). As water enters the cell from a hypotonic solution, pressure is applied to the plasma membrane until the cell ruptures. Water enters the cell due to osmotic pressure from the higher solute concentration in the cell. Osmotic pressure is measured as the force needed to stop osmosis. The strong cell wall of plant cells can withstand the hydrostatic pressure to keep the cell from rupturing. This is not the case with animal cells.

# The contractile vacuole of *Paramecium*: an evolutionary adaptation for osmoregulation

# Figure 7.15 Two models for facilitated diffusion




Diffusion down concentration gradient

# The sodium-potassium pump: a specific case of active transport

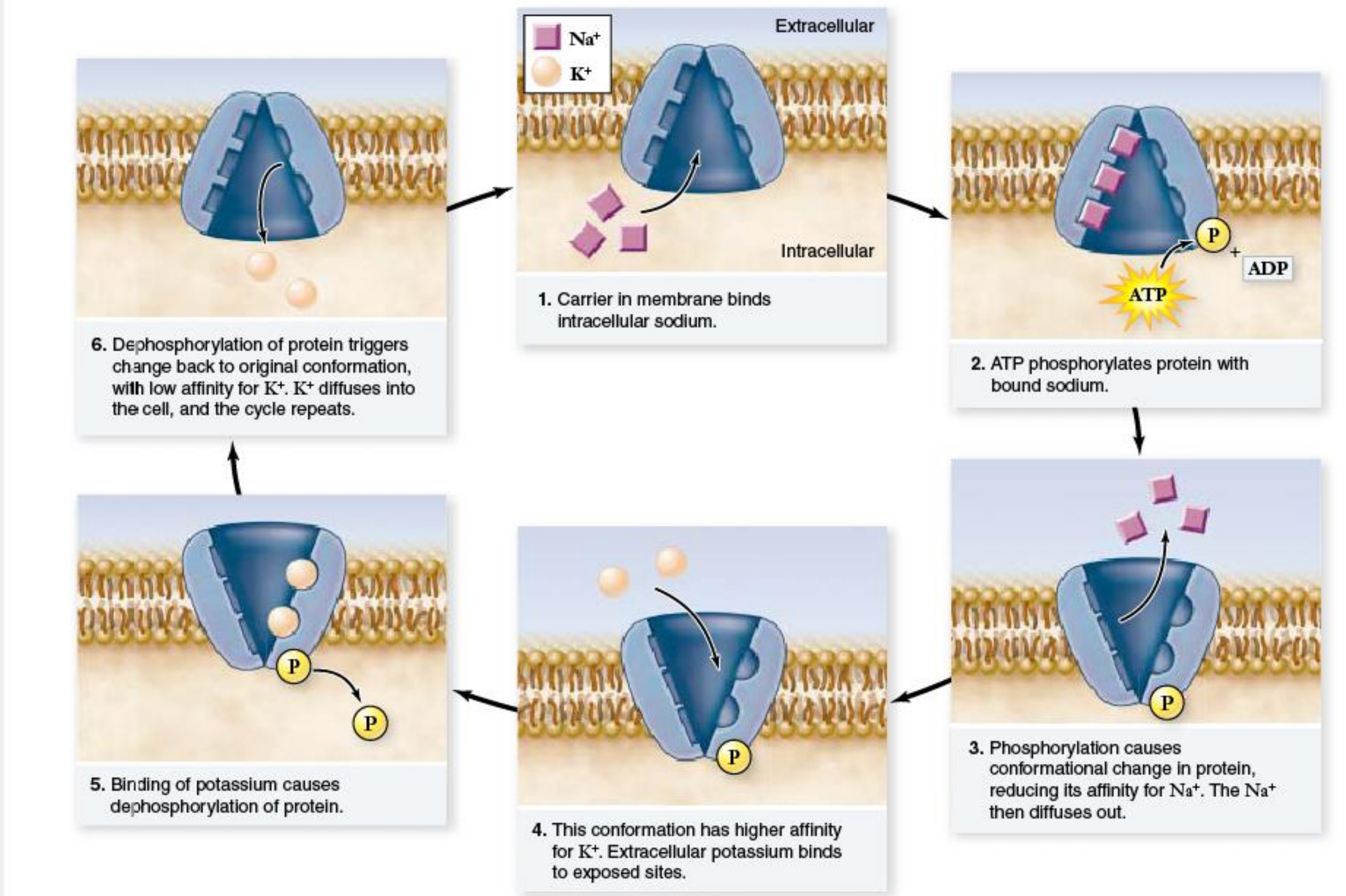



*figure 5.15*

**THE SODIUM–POTASSIUM PUMP.** The protein carrier known as the sodium–potassium pump transports sodium ($Na^+$) and potassium ($K^+$) ions across the plasma membrane. For every three $Na^+$ transported out of the cell, two $K^+$ are transported into it. The sodium–potassium pump is fueled by ATP hydrolysis. The affinity of the pump for $Na^+$ and $K^+$ is changed by adding or removing phosphate, which changes the conformation of the protein.

# Figure 7.19  Co-transport

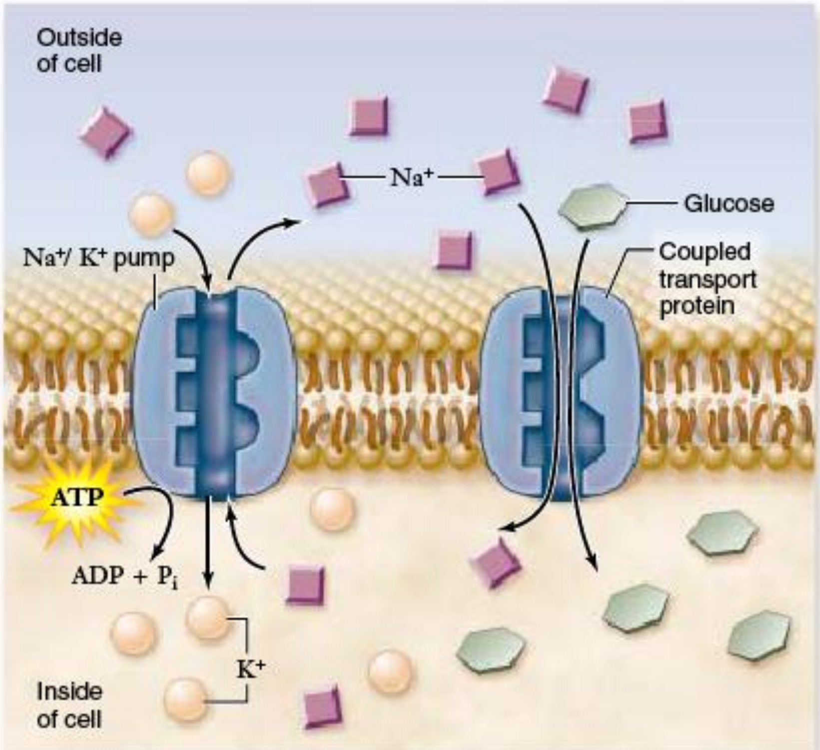



*figure 5.16*

**COUPLED TRANSPORT.** A membrane protein transports $Na^+$ into the cell, down its concentration gradient, at the same time it transports a glucose molecule into the cell. The gradient driving the $Na^+$ entry is so great that sugar molecules can be brought in against their concentration gradient. The $Na^+$ gradient is maintained by the $Na^+/K^+$ pump.

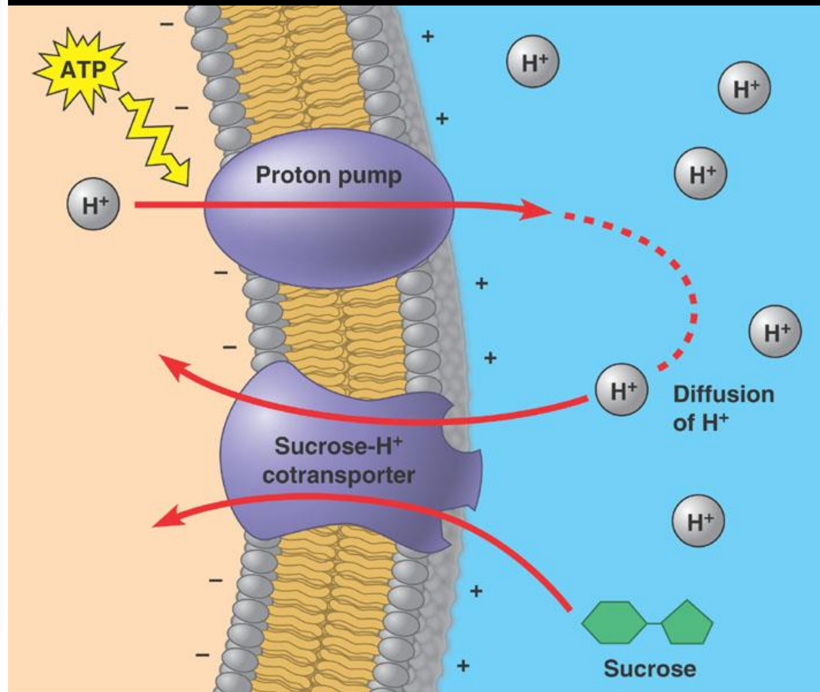
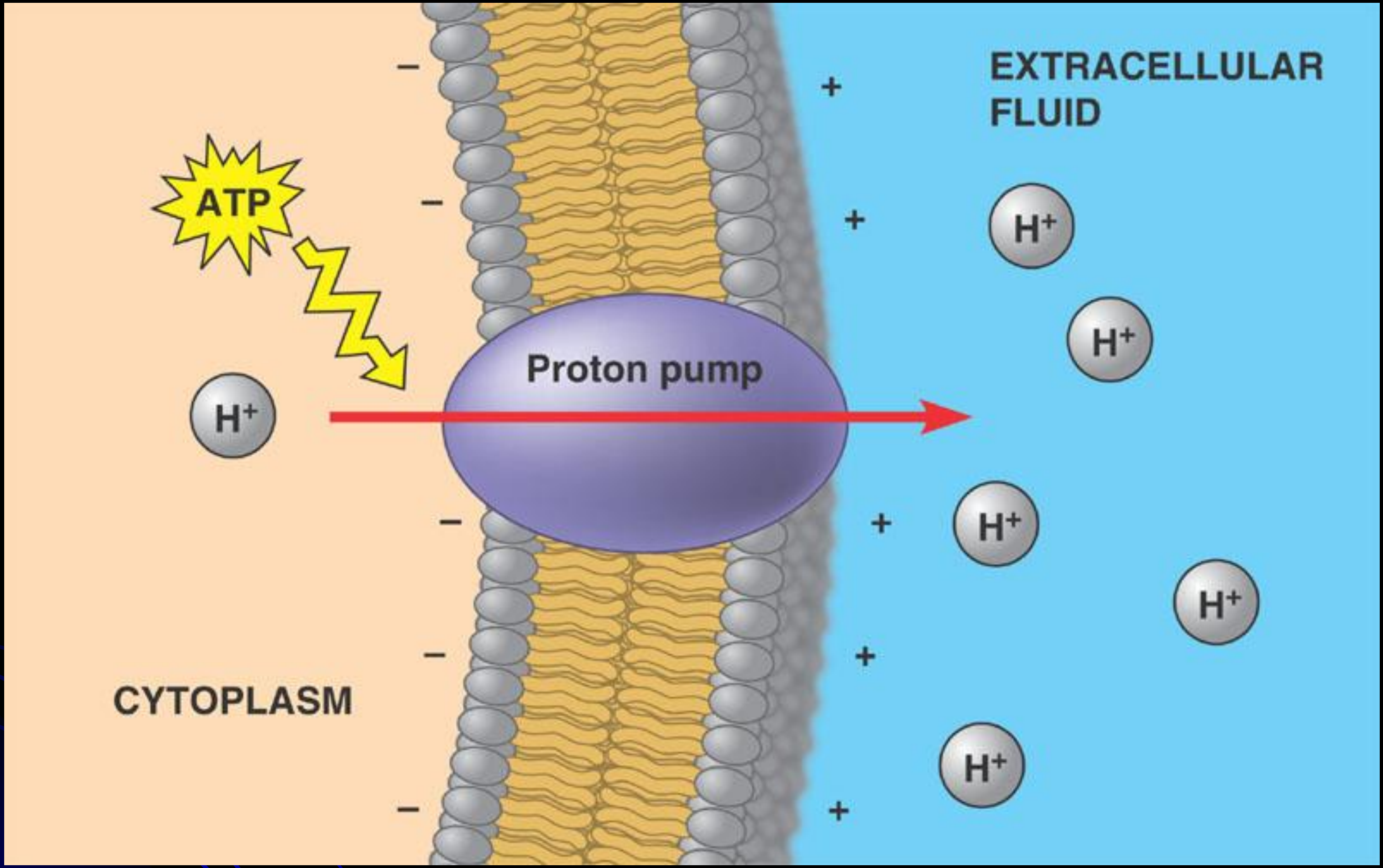
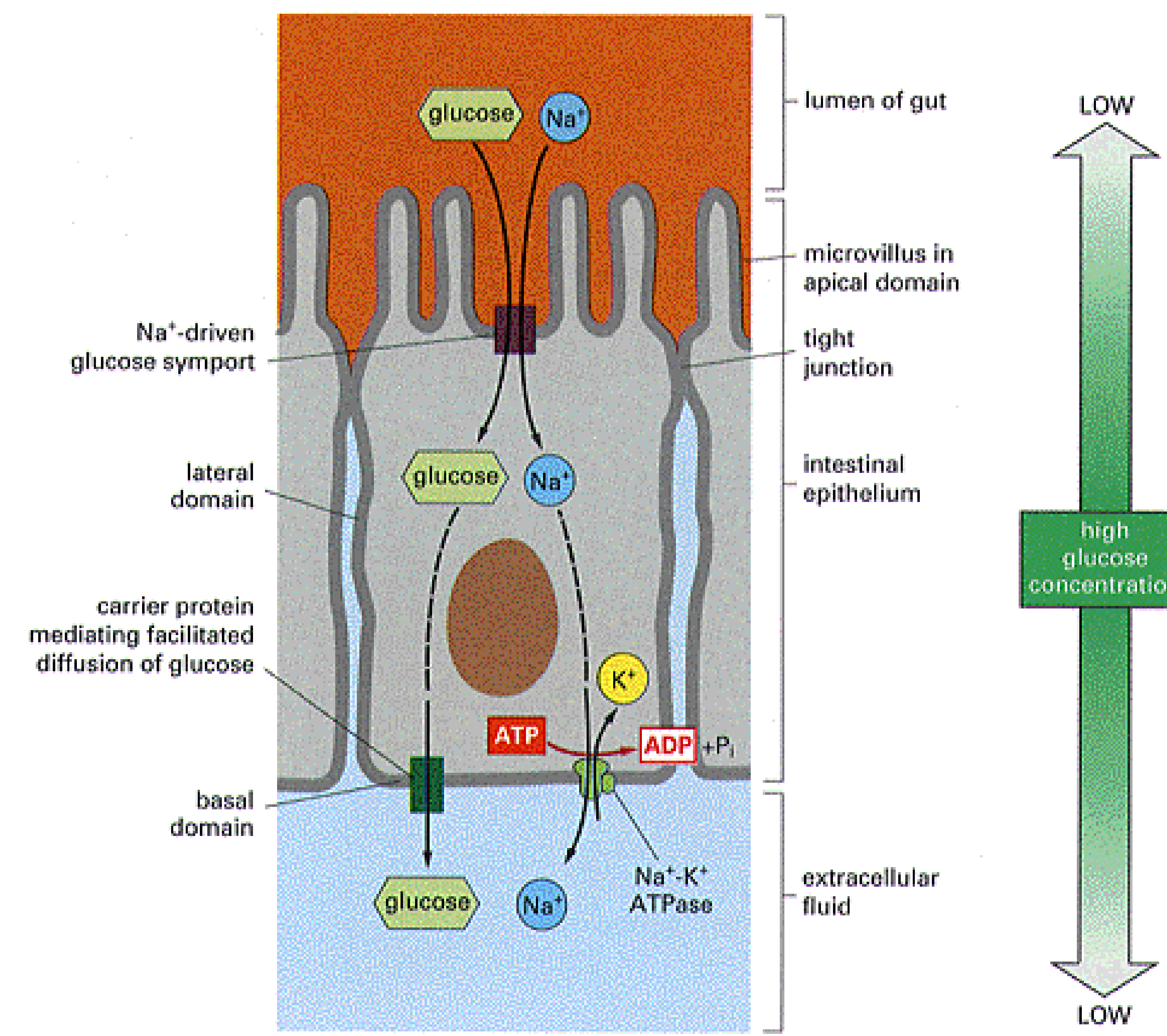


Figure 7.18 An electrogenic pump




**Electrogenic transport**: This is an active transport process driven by electric potentials.



glucose
Na+
lumen of gut
microvillus in apical domain
Na+-driven glucose symport
tight junction
lateral domain
glucose
Na+
intestinal epithelium
carrier protein mediating facilitated diffusion of glucose
K+
ATP
ADP +Pi
basal domain
glucose
Na+
Na+-K+ ATPase
extracellular fluid
LOW
high glucose concentration
LOW

# Passive transport

- Diffusion
  - Free-down concentration gradient
  - Across membrane
  - With or without channel proteins
    - Facilitated diffusion

# Active transport

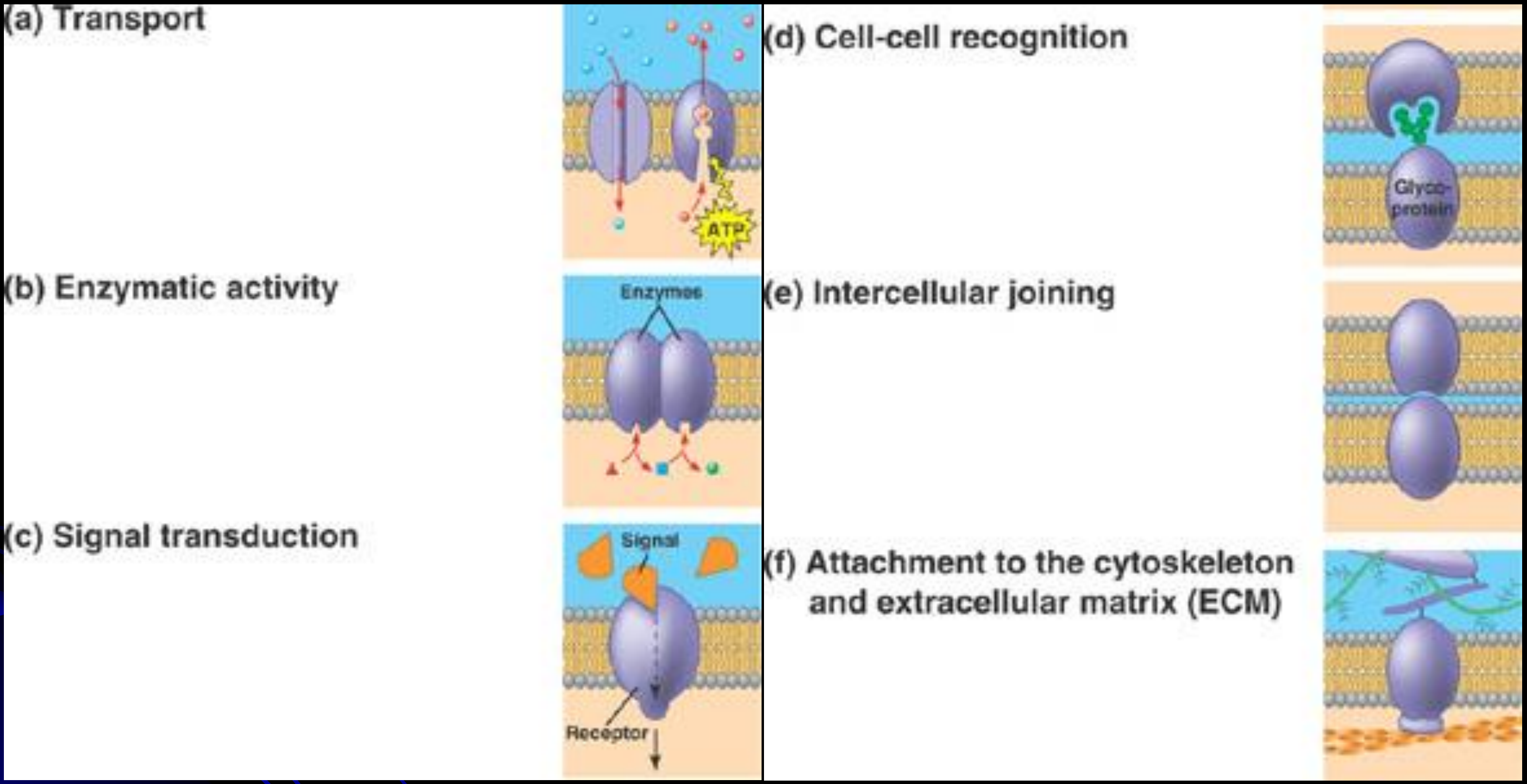
- Pumps molecules or ions against a concentration gradient
- Requires the input of energy
  - (e.g.  ATP, light)

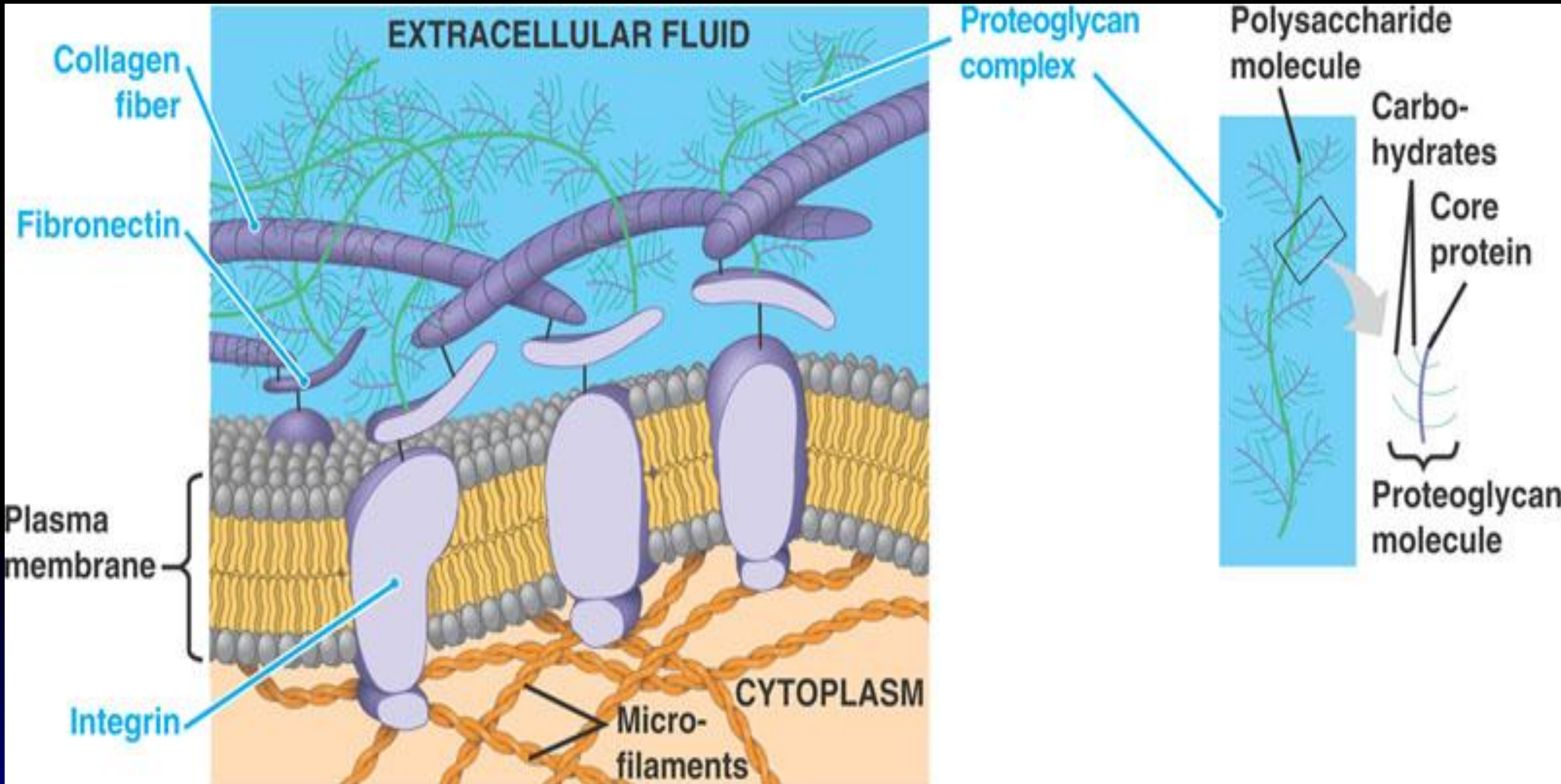
# Sodium ($Na^+$) Potassium ($K^+$) pump

- Cells maintain low intracellular [$Na^+$]
  - 440mM outside, 50 mM inside
- Cells maintain high intracellular [$K^+$]
  - 560mM inside, 90mM outside

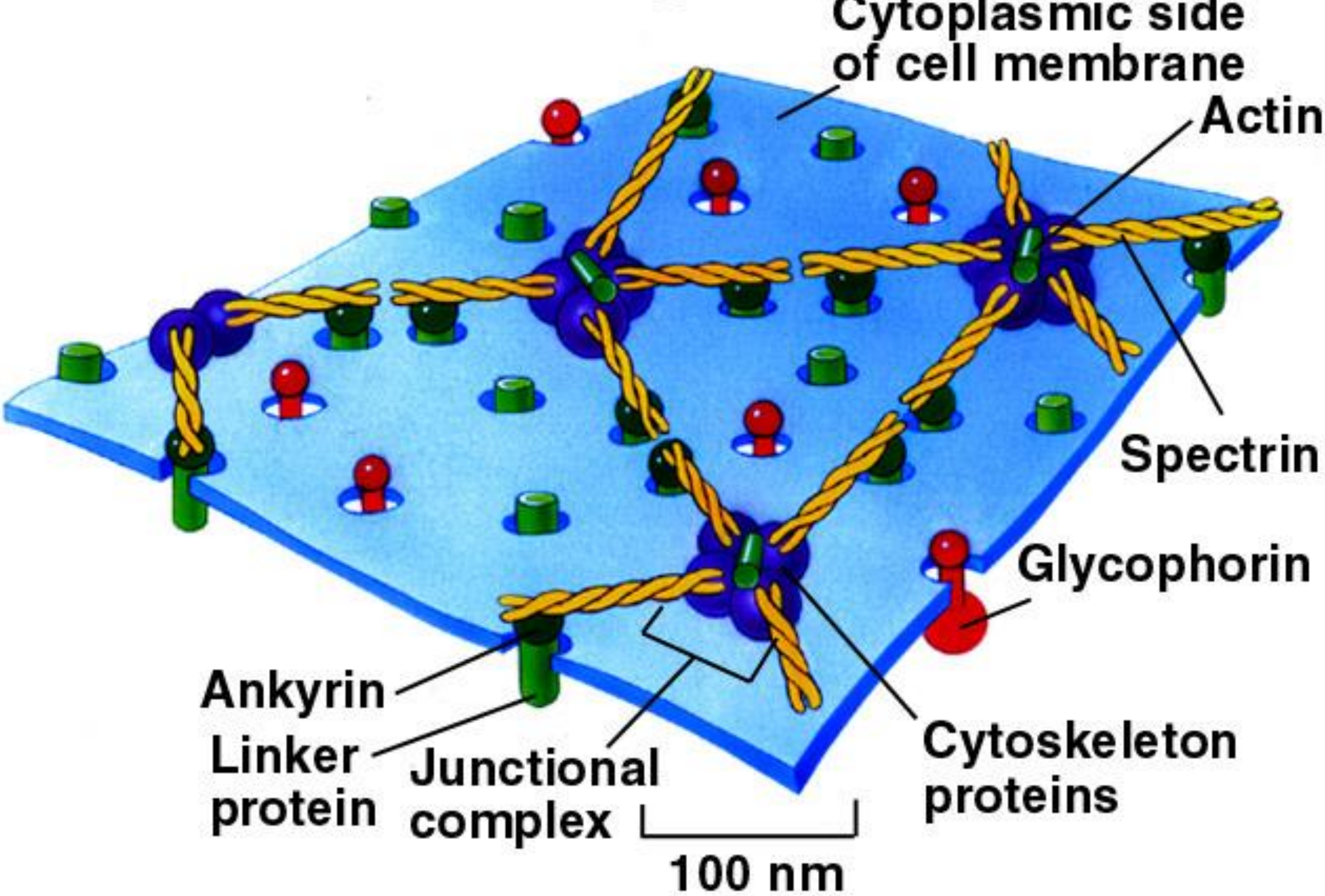
- Ions cannot diffuse through lipid bilayer
- Sodium-Potassium dependent ATPase

# Attachment to cytoskeleton

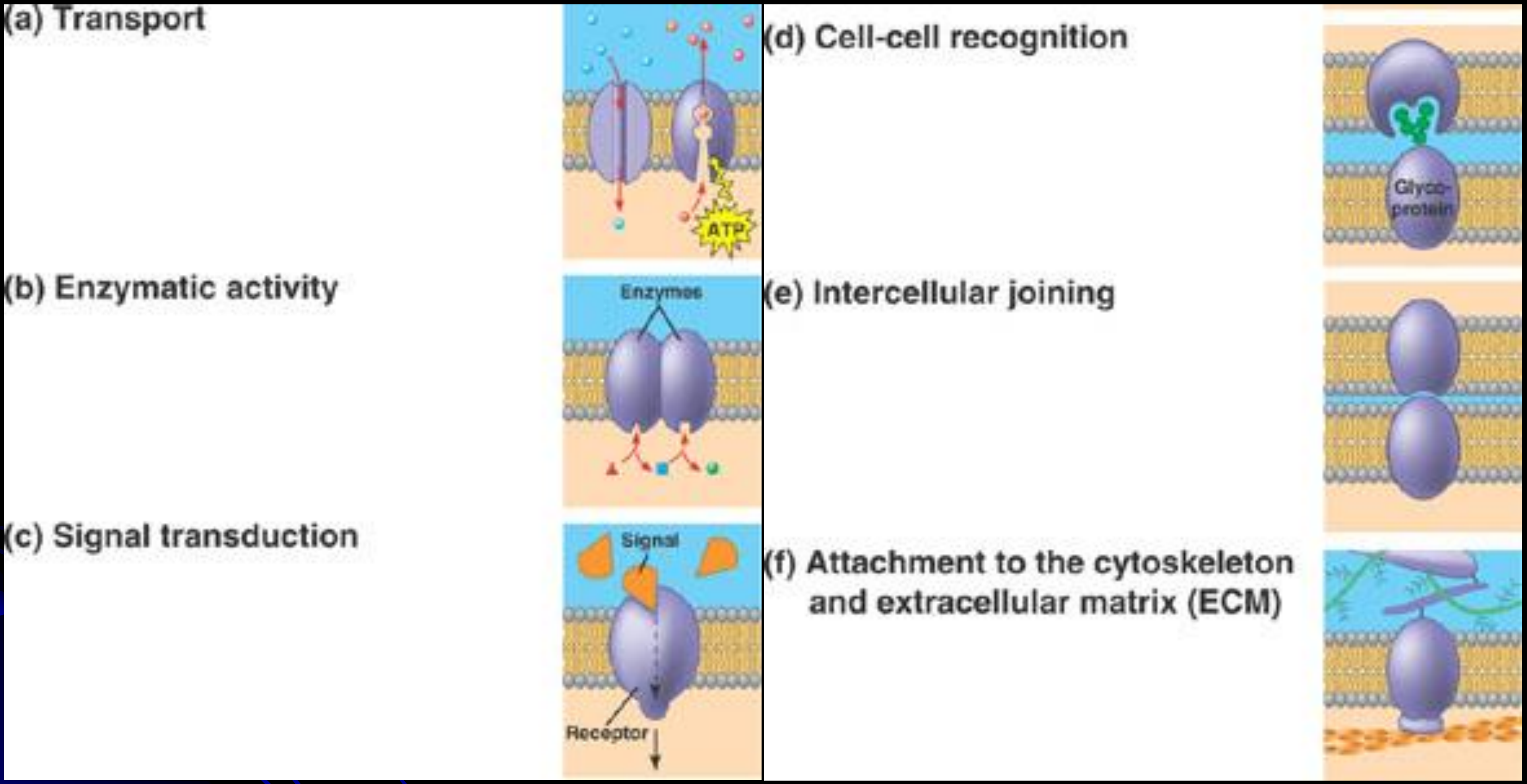



EXTRACELLULAR FLUID
Collagen fiber
Fibronectin
Plasma membrane
Integrin
Micro-filaments
CYTOPLASM
Proteoglycan complex
Polysaccharide molecule
Carbo-hydrates
Core protein
Proteoglycan molecule

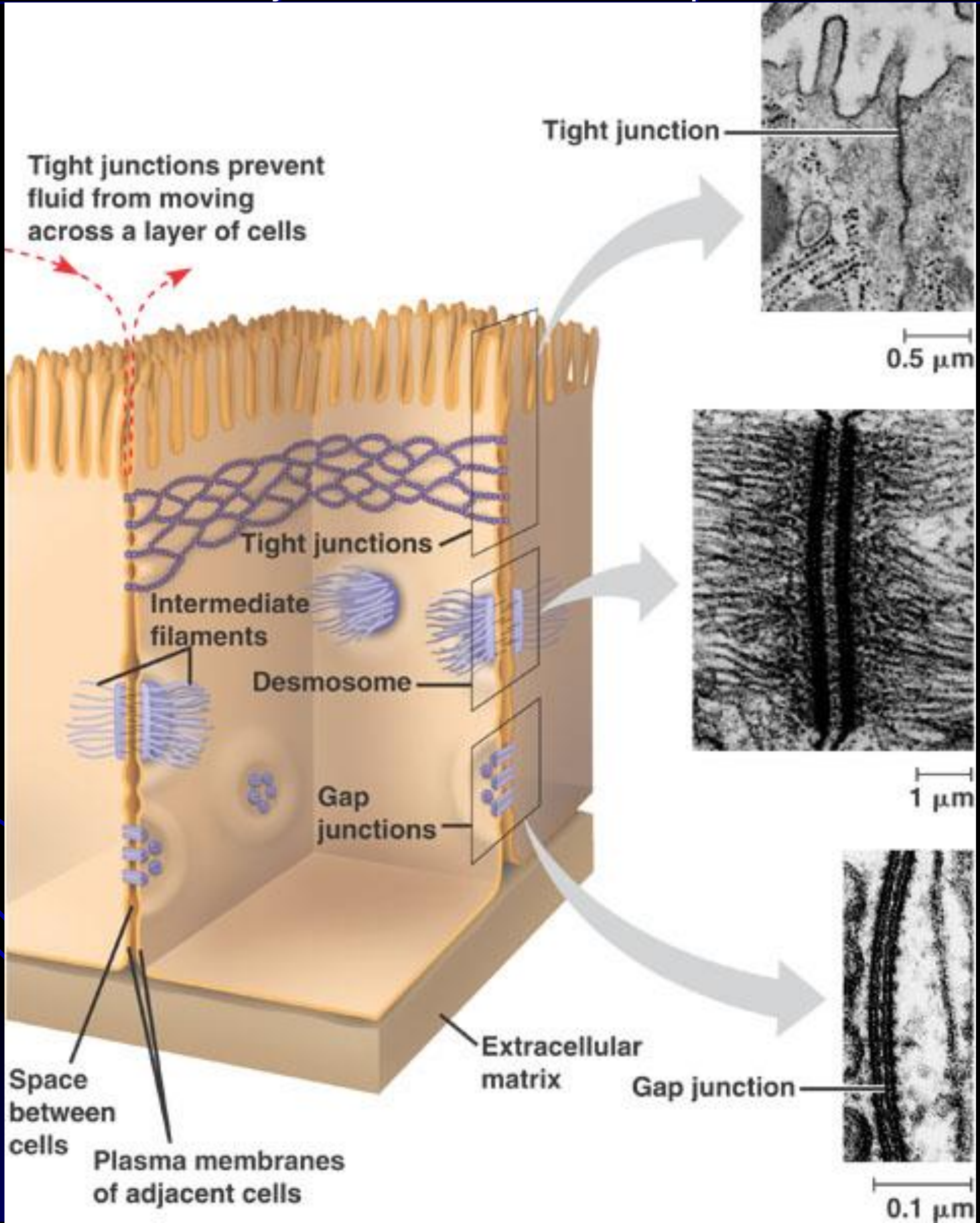
# Anchoring Proteins



# Intercellular joining



# Intercellular junctions in animal and plant tissues



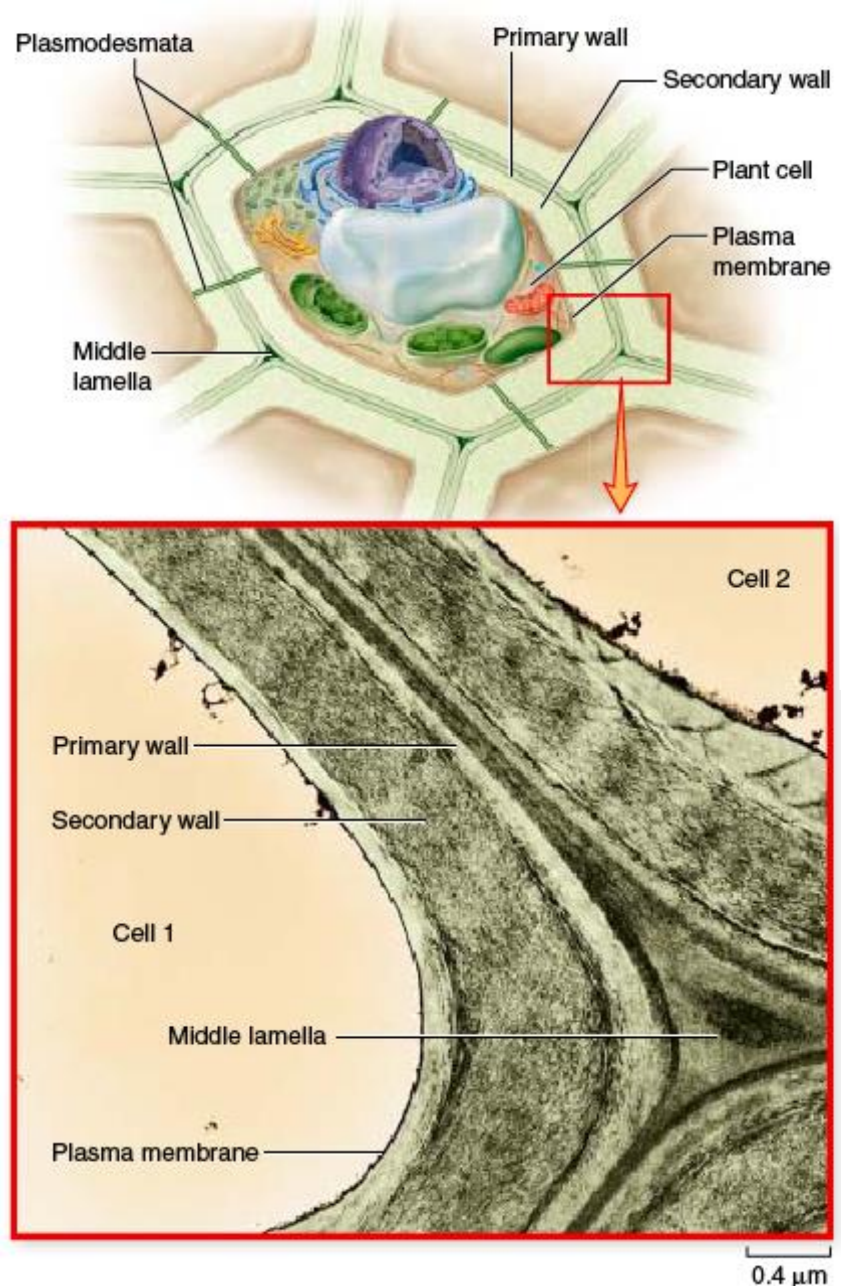
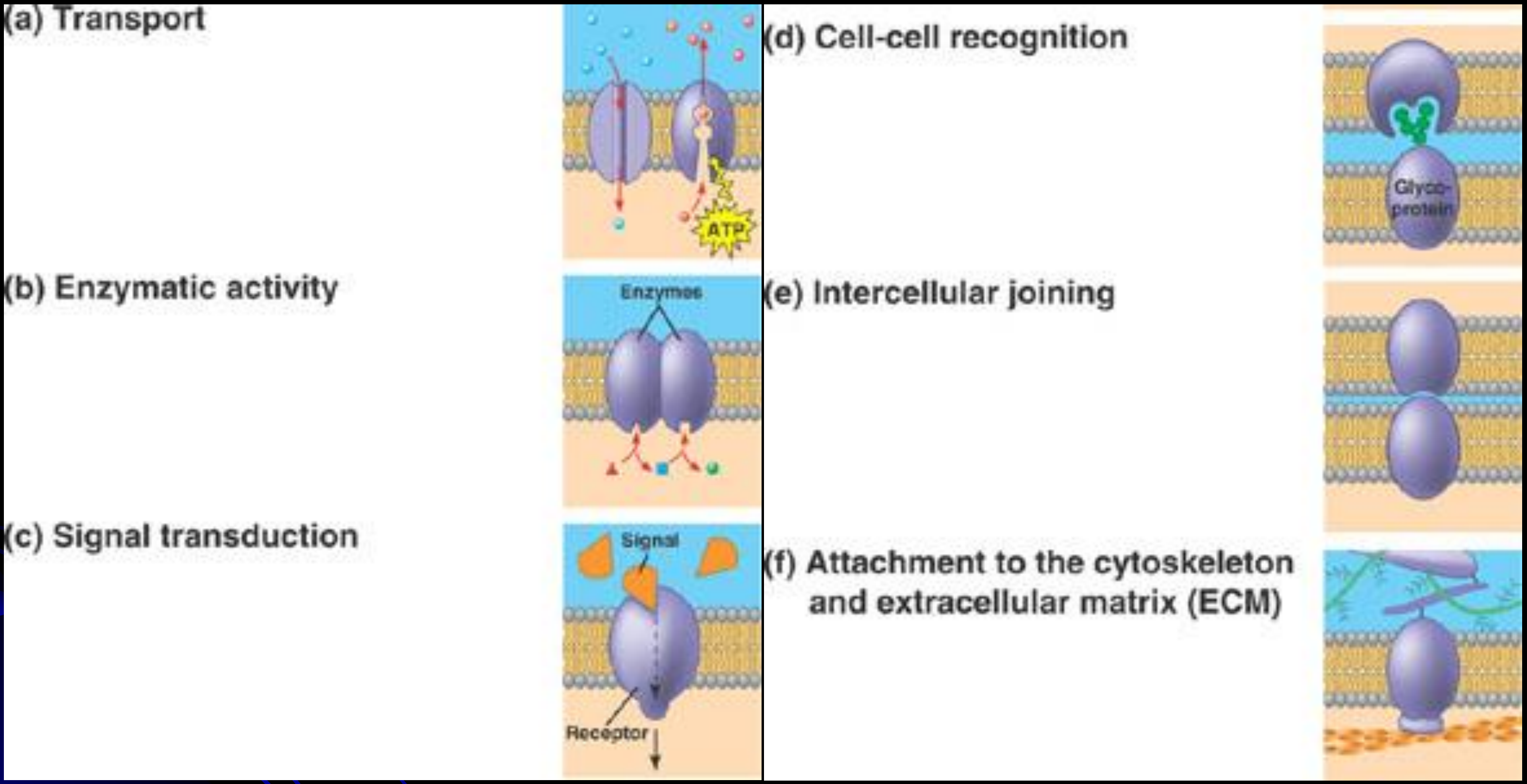


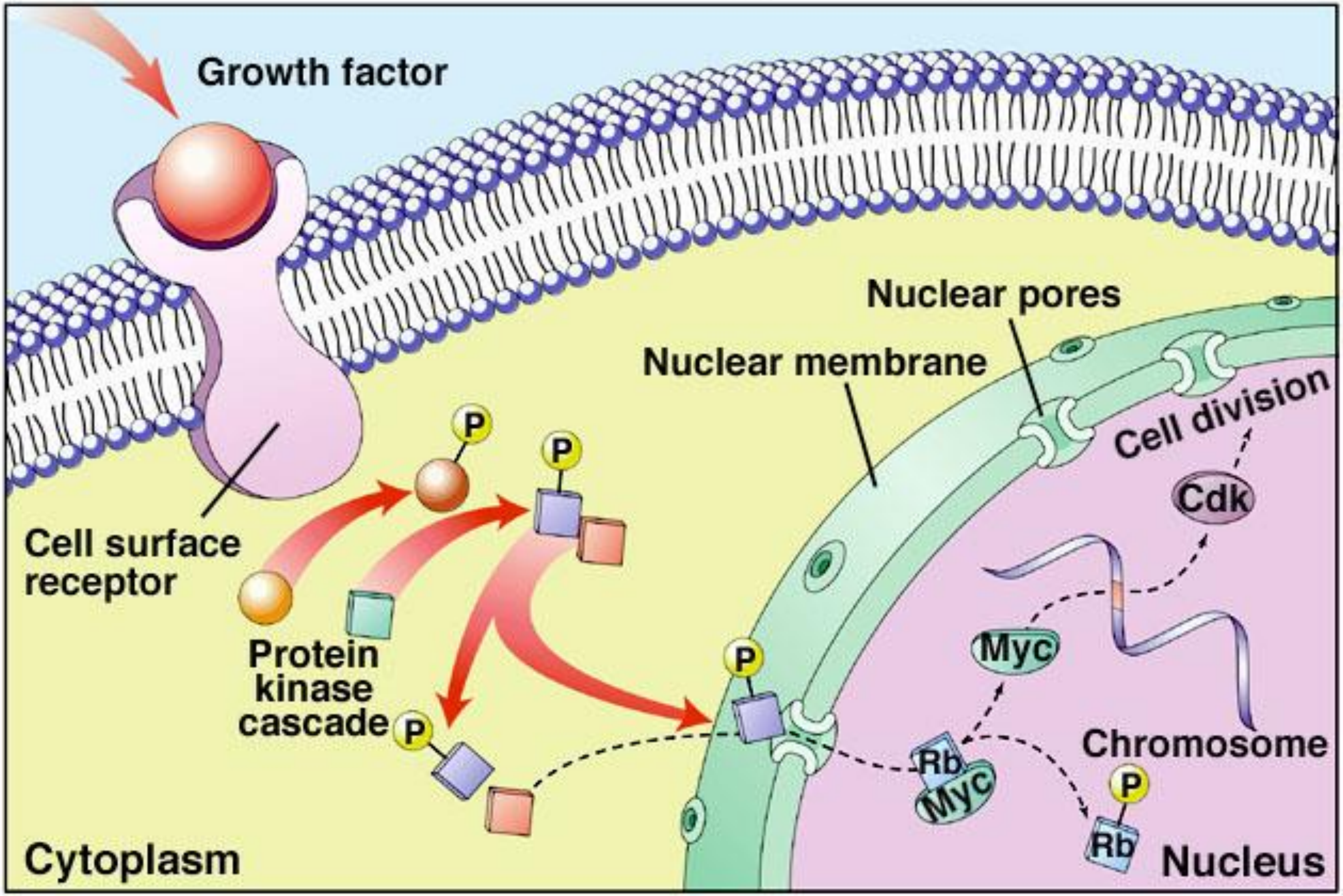

*figure 4.25*

**CELL WALLS IN PLANTS.** Plant cell walls are thick, strong, and rigid. Primary cell walls are laid down when the cell is young. Thicker secondary cell walls may be added later when the cell is fully grown.

# Signal transduction

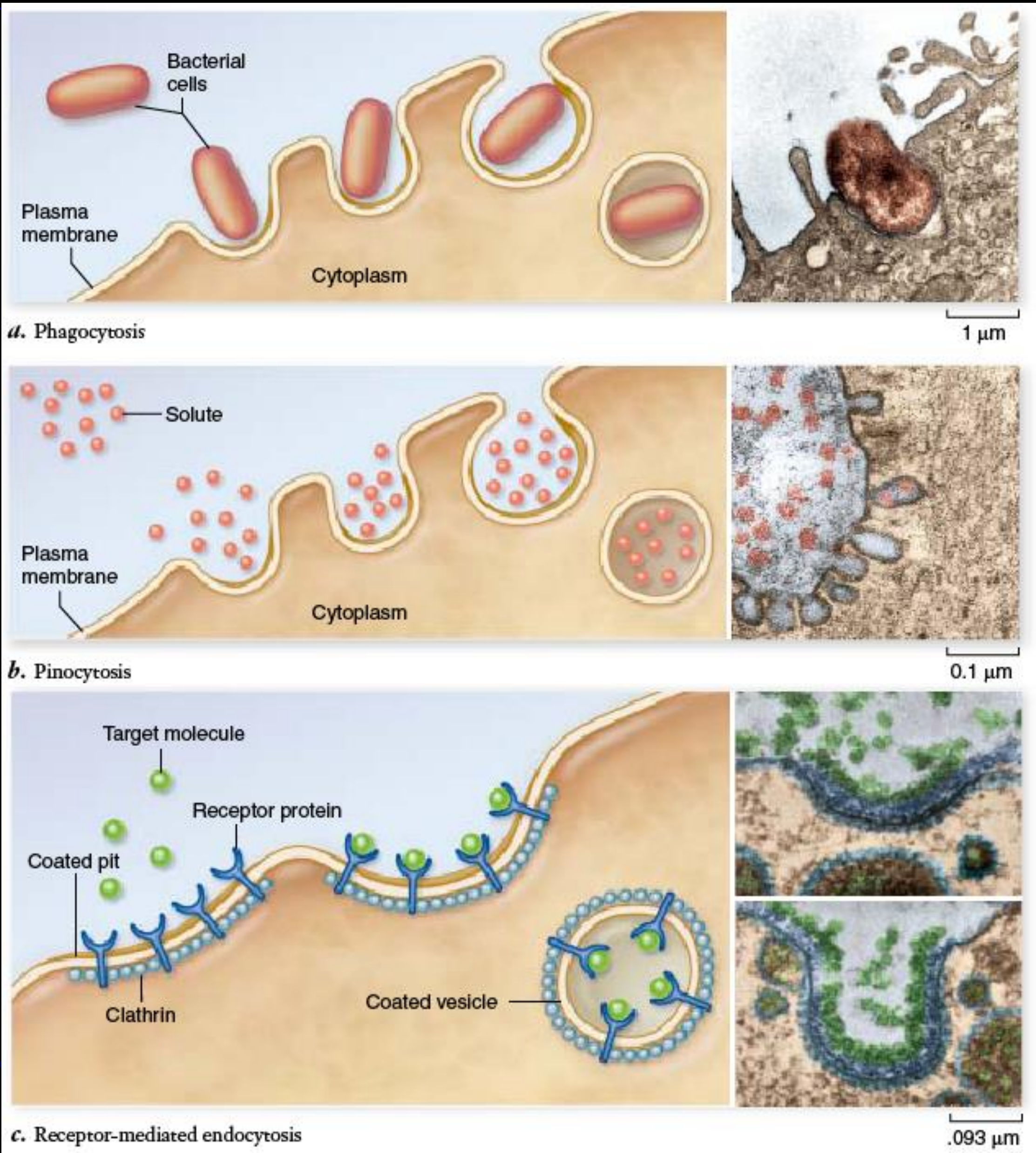


# Cell Proliferation-Signaling Pathway



The three types of endocytosis in animal cells

http://highered.mcgraw-hill.com/sites/0072437316/student_view0/chapter6/animations.html



# Exocytosis

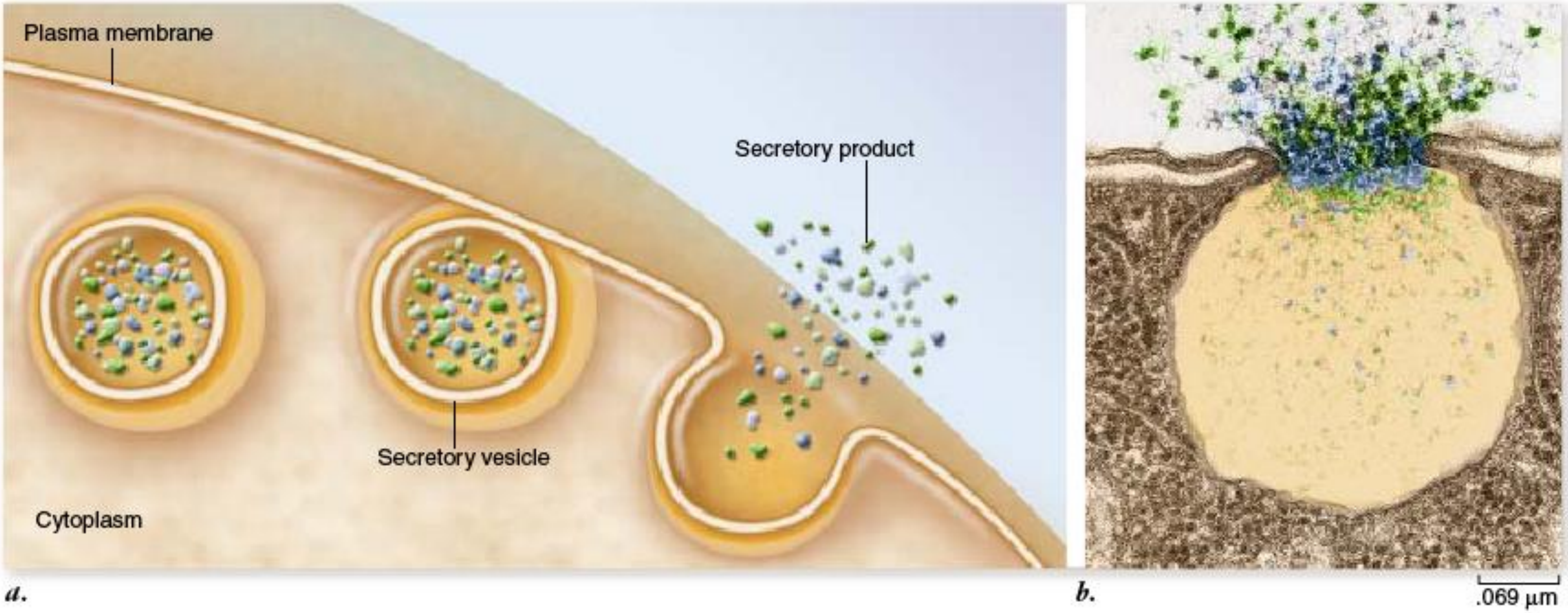



*figure 5.18*

**EXOCYTOSIS.** ***a.*** Proteins and other molecules are secreted from cells in small packets called vesicles, whose membranes fuse with the plasma membrane, releasing their contents outside the cell. ***b.*** A false-colored transmission electron micrograph showing exocytosis.